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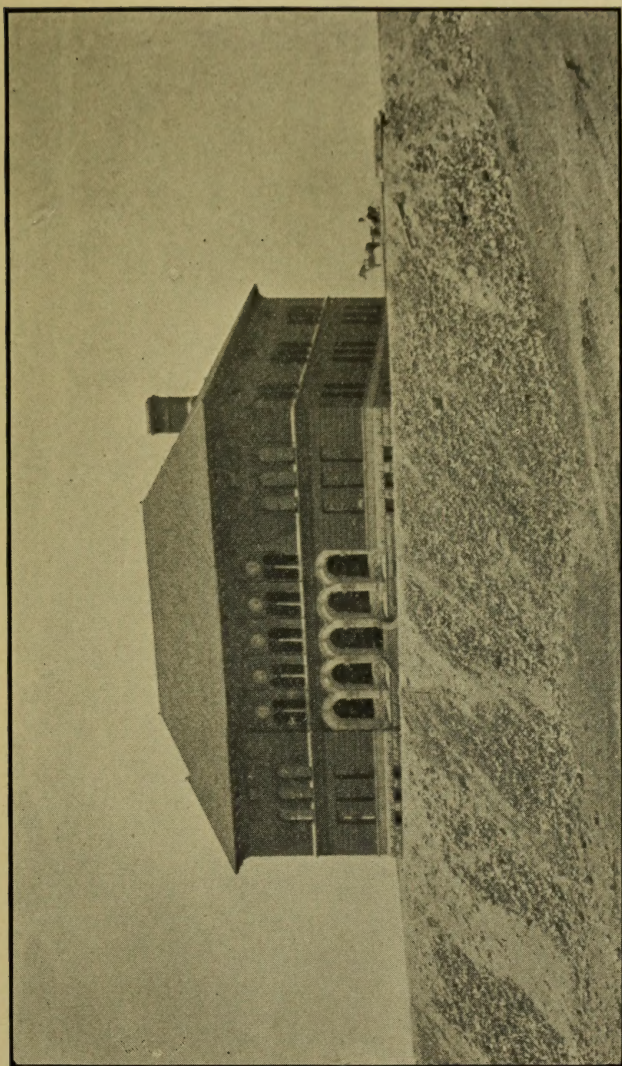
FIRST ANNUAL CATALOGUE

Montana State School of Mines

1900—1901

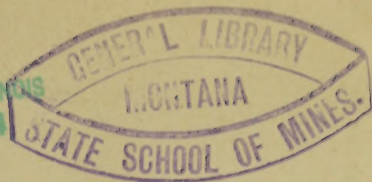
BUTTE, MONTANA

GENERAL LIBRARY
MONTANA
STATE SCHOOL OF MINES.



STATE SCHOOL OF MINES

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MONTANA ²⁰⁸⁰
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STATE SCHOOL
OF MINES
...BUTTE...

FIRST ANNUAL CATALOGUE

OF THE

OFFICERS AND STUDENTS
FOR THE YEAR

1900-1901

WITH

ANNOUNCEMENTS FOR THE YEAR
1901-1902.

BUTTE, MONTANA.

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1400/01-
1901-02

CALENDAR

FOR

1901-1902.

1901.

September 10.....First Semester Begins.

November 28.....Thanksgiving—Holiday.

December 20.....Holiday Recess to January 7, 1902.

1902.

January 23.....Term Examinations Begin.

January 24.....End of First Semester.

January 28.....Second Semester Begins.

February 12.....Lincoln's Birthday—Holiday.

May 30.....Memorial Day—Holiday.

June 5.....Term Examination Begins.

June 6.....End of Second Semester.

June 10.....Summer Excursion for Surveying
Begins.

July 22.....Summer Excursion Ends.

1902-1903.

September 9.....First Semester Begins.

MONTANA STATE SCHOOL OF MINES.

HISTORICAL SKETCH.—The foundation for the Montana State School of Mines was laid in the “Enabling Act” in pursuance of which the States of North and South Dakota and the States of Montana and Washington were admitted into the Union.

This Act made an appropriation of forty thousand acres of public land to each of the Dakotas, and one hundred thousand acres to the State of Montana for the establishment and maintenance in each of a State School of Mines. This was the first step taken by our national government for the promotion of institutions devoted to the education of the youth of our country in the specialties that relate to the mining industry. It came as the natural sequence of the Morrill act of 1862, which provided for the establishment of State schools for instruction in agriculture and the mechanic arts. Every State in the Union has organized at least one school under the Morrill act, and the experience of a quarter of a century has shown substantial benefits accruing to the States and the country at large from the adoption of that policy.

The great development of the mining industry in the years immediately following the Civil War, and especially the wonderful discoveries of the precious metals in the

Mountain States of the West gave to the calling of the miner an importance that attached to no other avocation save that of the farmer. It was easily seen that for the successful prosecution of his work the miner still more than the farmer was in need of a special education in the sciences that stand related to the occurrence of ores, and their extraction and proper treatment. It required no profound investigations in political economy to show that the prosperity of all our people was a result in which the prosperity of the miner was a most important factor.

It was on Washington's birthday in 1889 that this "Enabling Act" received the signature of the President of the United States. By this act our government became committed to the policy of promoting schools whose special purpose it should be to educate the rising generation in those branches that tend to fit them as theoretical and practical miners.

In due time these three States availed themselves of the provisions of the act of 1889. The State of Montana promptly accepted the donation of lands for a School of Mines, and appointed officers to select the amount allowed by the government. Thus far only 96,735 acres have been selected. Of these, 1,502 acres are classed as agricultural lands; 27,516 as timber, and 67,717 as grazing lands. The total appraisement of these lands is \$148,536.92, and the timber thereon is valued at \$221,975; or a total endowment value of \$370,506.92.

None of these lands and no timber has been sold. Leases have been given on 51,563 acres at a yearly rental approximating $6\frac{1}{4}$ per cent of their valuation. From this source an annual income is derived which will grow larger as

the lands increase in value and as more of them are leased. Last year the amount received from these leases was \$5,980.03.

The legislature of the State determined to have the School of Mines established and put in operation as soon as the necessary preliminaries could be arranged. It chose the city of Butte, the great mining center of the State, as the location for the school and appointed a commission consisting of five persons to prepare plans and specifications for the erection of buildings for its accommodation, and to contract for and supervise their construction.

This commission was composed of Hons. F. E. Sargeant, John Gillie, W. W. Dixon, J. H. Leyson and Charles W. Goodale.

The plot of ground upon which the School of Mines building was erected is made up of portions of the Mint lode, donated for the purpose by Gen. Charles S. Warren; the Vanderbilt lode, donated by Messrs. George H. Casey, Levi J. Hamilton, R. H. Wearing, Joseph R. Silver and Robert A. Day; and of the Montrose Addition, donated by Henry Haupt and others. The dimensions of this plot are 376 feet in breadth by 500 feet in length. It is located about 80 rods west of the western boundary of the city on the southern bench of "Big Butte." The situation commands a fine view of the city and surrounding country and with the early completion of the city railway will be easy of access to the mining, the business and the residence portions of the city.

The School of Mines building was erected in 1896-7. Its dimensions are 94 feet by 118. It is three stories in height, with a spacious unfinished attic which is practi-

cally equivalent to another story. The foundation story is of stone. Those above are of brick. It is nearly, but not absolutely, fire-proof. The floors of the lower or basement story are of cement. The stairways are of stone resting on stone pillars and arches of brick. The halls are floored with tile laid in cement and metallic lath were used in plastering. The plan of the building was well conceived, and it is often spoken of as the most substantial public structure in the State. No part of the expense for the erection of this building was borne by the State. The legislature authorized the issue and sale of thirty-year bonds to the amount of \$120,000. These bonds bear interest at the rate of 5 per cent, and are redeemable after fifteen years. The State pledges the donated lands and all the income derived in any way therefrom to the redemption of these bonds, and further pledges itself to make good any deficiencies in the payment of interest, charging back, however, any sums that may be thus advanced to the landed endowment of the institution. The bonds were sold at par August 20th, 1900. The moneys that had been needed from time to time in the erection of the building were advanced by citizens of the city and State, and these moneys have now been refunded, or are being refunded, from the proceeds of the bond sale.

At its session in 1899 the State legislature appropriated \$26,300 for the equipment of the building and for the maintenance of the School up to the close of the fiscal year, November 30, 1900. The larger part of this sum was used in the purchase of furniture and scientific apparatus. In making these purchases it has been the declared purpose of the management that everything obtained should be of the best quality and of the most modern construction.

At its session in 1901 the legislature made a further appropriation of \$57,861.77 to add to the equipment and for the maintenance of the institution for the two years ending November 30, 1902.

The School of Mines was opened for the reception of pupils September 11, 1900. A large number of young people desired admission, but as it was not permissible to open a preparatory department four-fifths of these requests had to be refused for lack of sufficient educational preparation. As many of those who were thus refused admission were worthy young men of mature years, many of them having more or less practical experience in mining, it was felt that something ought to be done to favor this class of persons in the future. After consultation with the State Board of Education an arrangement was made whereby those who are prepared to take up some lines of work in the school may be admitted and at the same time receive instruction in preparatory lines as is detailed elsewhere.

The total number admitted during this year is 39. According to printed statistics this is a larger number than was secured by any similar institution during the first year of its existence. The Michigan School of Mines reports only 23 students for its first year, 29 for the second, and 40 for the third year. Last year it had a total attendance of 121. The Colorado School of Mines had an equally humble beginning, but now has an attendance of nearly 200.

The demand for a School of Mines in this, the "Treasure State," is very urgent, and as soon as our preparatory and High Schools are well established and doing their ap-

propriate work the number of pupils that will come hither from Montana alone will severely tax the resources and accommodations that this institution will have at its command.

BOARDS OF CONTROL.

The general control of the higher educational institutions of the State of Montana is, by our Constitution, vested in the State Board of Education, subject to the laws of the commonwealth. This control, in the case of the School of Mines, is exercised through a local Board of Trustees.



STATE BOARD OF EDUCATION.

JOSEPH K. TOOLE.....Helena
*Governor of the State and Ex-Officio President of the
 Board.*

W. W. WELCH.....Helena
*State Superintendent and Ex-Officio Secretary of the
 Board.*

JAMES DONOVAN.....Helena
*Attorney General of the State and Ex-Officio a Member of
 the Board.*

J. M. HAMILTON, Missoula.	}	Term Expires Feb. 1, 1902.
J. P. HENDRICKS, Butte.		
S. W. MCCONNELL, Helena.	}	Term Expires Feb. 1, 1903.
O. F. GODDARD, Billings.		
O. P. CHISHOLM, Bozeman.	}	Term Expires Feb. 1, 1904.
J. G. MCKAY, Hamilton.		
J. F. PAUL, Dillon.	}	Term Expires Feb. 1, 1905.
NORMAN B. HOLTER, Helena		

BOARD OF TRUSTEES.

JOHN E. RICKARDS, Butte.....Chairman
 (Term expires January 1, 1904.)

GEO. E. MOULTHROP, Butte.....Secretary
 (Term expires January 1, 1904.)

W. A. CLARK, JR., Butte.....Treasurer
 (Term expires January 1, 1904.)

GEO. H. ROBINSON, Butte.
 (Term expires January 1, 1902.)

W. Y. PEMBERTON, Butte.
 (Term expires January 1, 1902.)

FACULTY OF THE MONTANA STATE SCHOOL OF MINES.

NATHAN R. LEONARD, A. M.,
President and Professor of Mathematics.

WILLIAM G. KING, A. M.,
Professor of Chemistry and Metallurgy.

ALEXANDER N. WINCHELL, Doct. Univ. Paris,
Professor of Geology and Mineralogy.

CHARLES H. BOWMAN, M. S.,
Professor of Mechanics and Mining Engineering.

LEON R. FOOTE, B. L.,
Teacher of Conditional Classes.

*
Charles W. Clark Professorship of Mining Engineering.

* Not yet filled.

CONDITIONS OF ADMISSION.

The School of Mines is open on equal conditions to all residents of the State without regard to sex or race, and to the youth of other States and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be sixteen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra to quadratics, plane geometry, geography, elementary zoology or physiology, physical geography and English composition.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right, at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

Those who may be qualified for admission to some of the studies of the regular course, but are deficient in preparation for other studies may be admitted and receive instruction under Professor Foote in those branches in which their preparation is deficient.

Graduates from the "accepted" High Schools of the State will be admitted without examination, on presentation of their diplomas.

LIST OF ACCEPTED HIGH SCHOOLS.

Butte,	Missoula,
Helena,	Anaconda,
Great Falls,	Kalispell,
Bozeman,	Miles City.

CONDITIONED CLASSES.

It has not been considered advisable to create here a general Preparatory Department similar to those connected with the other State Schools of Montana. The School of Mines is to be maintained as a technical school and its energies confined within the sphere for which it was established. The general education of the youth of the State is provided for elsewhere. It is evident that the very fact of its purpose to confine its work to certain specialties makes it necessary that greater emphasis should be laid upon certain branches of preparatory education, particularly those of a mathematical and scientific character, than might be advisable in some other institutions.

The general rule by which all graduates of "accepted" High Schools of the State are to be admitted without examination to all the institutions for higher education, and even the regular examinations for admission will not always insure such full and adequate preparation as is needed for a satisfactory prosecution of the work.

To provide such facilities as seem to be needed at present, arrangement has been made for what are known as "conditioned" classes.

These classes are formed for the accommodation of those who come from localities where there are but meagre op-

portunities for preparatory education, and also for those who may not prove to be adequately prepared in one or more subjects. No student, however, will be admitted to any of these conditioned classes who is not qualified for admission to some branch of study in the regular college course.

The only subjects that will be taught in these classes are those necessary for admission to the Freshman class. [See Requirements for Admission, p. 13.)

COURSES OF STUDY AND DEGREES.

The course of instruction adopted for the School of Mines allows an election in the Junior and Senior years between certain studies, and for convenience these different lines of study are called respectively, The Course in Mining Engineering and The Course in Electrical Engineering. Those who complete the first of these will be entitled to the degree of Mining Engineer (M. E.) ; those completing the second, to the degree of Electrical Engineer (E. E.). These courses are here given in tabular form; the figures following each topic represent the number of hours per week given to class-room or laboratory work in that topic.

COURSE IN MINING ENGINEERING.

FRESHMAN YEAR.

First Semester.

Higher Algebra.....	5
Geometry	4
General Chemistry	8
Drawing	15

Second Semester.

Higher Algebra, half semester.....	5
Surveying, half semester.....	5
Trigonometry	4
Descriptive Geometry.....	4
Drawing	6
Qualitative Analysis.....	9

Six Weeks' Vacation Work in Surveying.

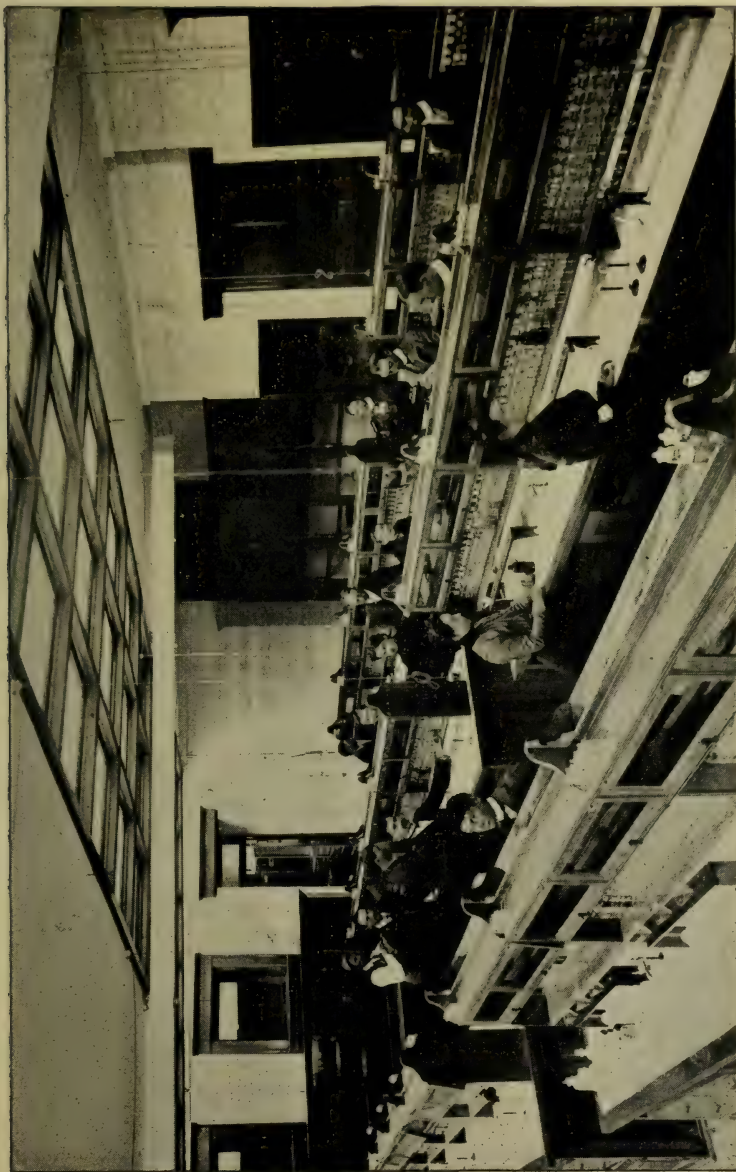
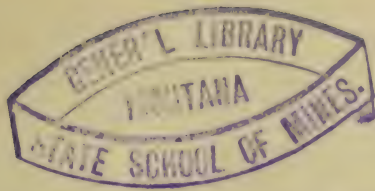
SOPHOMORE YEAR.

First Semester.

Analytical Geometry	5
Mineralogy	7
Physics	5
Quantitative Analysis—Laboratory.....	9
Mechanical Drawing.....	4

Second Semester.

Differential Calculus	4
Mineralogy	8
Physics	7
Quantitative Analysis.....	9
Drawing	3



CHEMICAL LABORATORY

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JUNIOR YEAR.

First Semester.

Integral Calculus	5
Geology	5
Mechanics	2
Metallurgy—Lectures and Recitation.....	3
Machine Design and Drawing, half semester....	9
Assaying, half semester.....	9

Second Semester.

Economic Geology	5
Metallurgy—Lecture	3
Metallurgy—Laboratory	9
Graphical Statics.....	5
Mine Surveying	2
Mechanics	5

Vacation, Six Weeks' Mine Surveying.

SENIOR YEAR.

First Semester.

Metallurgy	4
Petrography	7
Mining	5
Hydraulics	5
Mining and Metallurgic Design	6
Testing Laboratory.....	3

Second Semester.

Metallurgy—Lecture and Excursions	5
Mining—Lecture and Excursions	5
Power Transmission	3
Mining Engineering	3
Petrography	3
Mining Law—Lecture	1
Microchemical Analysis	1
Thesis	9

COURSE IN ELECTRICAL ENGINEERING.

(The Freshman and Sophomore Years are the same as those of the Mining Engineering Course.)

JUNIOR YEAR.

First Semester.

Integral Calculus	5
Dynamo Machinery	3
Electrical Laboratory, half semester.....	9
Machine Design and Drawing, half semester.....	9
Mechanics	2
Electrical Measurements—Laboratory	9

Second Semester.

Economic Geology	5
Dynamo Machinery	3
Electrical Design	3
Electrical Measurements—Lecture.....	1
Electrical Measurements—Laboratory.....	9
Electrical Engineering	2
Shop Work	6

SENIOR YEAR.

First Semester.

Hydraulics	5
Transformers and Alternating Currents.....	3
Dynamos—Laboratory	3
Electrical Design and Shop Work.....	6
Photometry and Electric Lighting.....	5

Second Semester.

Power Transmission	5
Steam-Engine	3
Electrical Design and Shop Work.....	6
Electricity in Mining—Lecture.....	1
Mining Law—Lecture.....	1
Thesis	12

DEPARTMENTS.**MATHEMATICS.**

The course in Mathematics extends through the first three years. Half the time of the Freshman year is given to this study because of its importance as a preparation for most of the remaining studies of the Engineering course.

ALGEBRA.—The study of Algebra will begin with quadratics in the Higher Algebra, and will continue for 30 weeks—five recitations per week.

GEOMETRY.—Solid Geometry will also be begun at the commencement of the Freshman year and completed by the end of the first semester.

TRIGONOMETRY.—Plane and Spherical Trigonometry will be taken up during the second semester of the Freshman year, and continued through that term. Wentworth's text-books will be used through the year.

ANALYTICAL GEOMETRY.—This study will be commenced the first semester of the Sophomore year. The different systems of coordinates, the properties of the conic sections and higher plane curves, and the relation of lines and surfaces in space, will be carefully examined with particular reference to the practical applications of the knowledge thus acquired to the pursuits of the engineer.

CALCULUS.—The Differential and Integral Calculus will occupy the last half of the Sophomore and the first half of the Junior year. The instruction will mainly be given by lecture, with Taylor's and Byerly's Treatises as works of reference.

CHEMISTRY AND METALLURGY.

GENERAL CHEMISTRY.—General Chemistry extends through the first half of the Freshman year. It consists of experimental work by each student at his desk covering the subject of inorganic chemistry, including the metals. He is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions upon each other. This work is the foundation upon which his general knowledge of chemistry is based and he is required to keep accurate notes, recording the reactions and principles involved in each experiment. Recitations are held covering the theoretical part of the work gone over.

This laboratory work is supplemented by a course of one lecture a week extending through the year, the student being required to take such notes as will enable him to explain in the class-room the principles involved and illustrated on the lecture table. The student will be required to read various standard works on general chemistry.

QUALITATIVE ANALYSIS.—The second half of the Freshman year in the laboratory is devoted to qualitative analysis. The student studies the general schemes of analysis by which the various metals are separated from each other; then the acid radicals are detected and separated. The course covers the separation of metals in solution, dry salts, alloys and minerals in the wet way. The student must become conversant with all reactions involved and the writing and balancing of chemical equations. The spectroscope is used in connection with qualitative work

for the detection of the fixed alkalies and the alkaline earths.

This work is supplemented by lectures and recitations.

QUANTITATIVE ANALYSIS.—Quantitative Analysis extends through the whole of the Sophomore year. The work embraces all the work as carried on in the laboratories of the smelters, mills and mining plants. The various products of the smelters, such as crude ores, calcines, slags, mattes, flue dust, etc., are analyzed completely. The student, after being taught the technical methods of analysis will be required to practice rapid methods and the performing of a large number of determinations in one afternoon as required in actual smelter and mill work.

The course covers thoroughly the whole subject of mineral analysis, including gravimetric, volumetric and colorimetric methods, the analysis and calorific power of coals, the analysis of gases of combustion and illuminating gas, the standardization of solutions in acidimetry and alkalimetry, the standardization of cyanide solutions and the determination of gold and silver in cyanide solutions, the specific gravity of solids and solutions by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation-room and problems in chemistry solved. Various novel and special analyses are worked and illustrated at the lecture table. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed.

The chemical laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student

will have at his desk, water, sink, gas, blast, and exhaust; and the extent of the practical work will be limited only according to his abilities and industry.

METALLURGY.—The subject of metallurgy begins with a thorough course in assaying during the latter part of the first semester of the Junior year. It includes fire assays of gold, silver and lead in crude ores and smelter products, such as slags, mattes, copper and lead bullion, etc.

The laboratory is fitted with the most modern apparatus. Gas muffle and melting furnaces will be used. The retorting of amalgam, melting and refining of gold and silver bullion, and sampling and assaying of pig copper and lead. Every convenience known at the present time will be at the command of the student and the most modern and reliable balances will be used in assay work.

A course will be given in the metallurgy and refining of copper and the recovery and purification of the bi-products of gold and silver from the copper bullion. Various excursions to the smelters and reduction plants of Butte and Anaconda will be undertaken as the special subjects come before the student where are practically illustrated all the various methods of treatment. With these processes of treatment at our very doors, the opportunity of seeing them will be surpassed by no single locality in the world. The operations of treatment from high and low grade ores as taken from the mines, to the refined products, can each be followed accurately and by nearly all of the various known methods. No two smelters of Butte are identical in operation.

The metallurgy of lead will be thoroughly treated by recitations, lectures and visits to the lead smelters of Montana. Also the metallurgy of iron, nickel, cobalt, zinc, aluminum, etc., and wherever practicable, excursions will be undertaken to see practical workings of these processes.

The various methods for the most advantageous treatment and extraction of the precious and useful metals from their various ores will be demonstrated by the student and checks made upon his work by means of analyses and assays. The comparative merits of the cyanide, amalgamation, hyposulphite, chlorination and other methods of treatment upon a given ore will be compared and determined. Excursions will include the cyanide and other mill plants and notes and reports required of the student concerning the details of these various processes examined.

GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the general principles of crystallography, and of the various forms of each crystal system. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. Crystal aggregates receive attention, and the various methods of notation of crystal faces, and of drawing crystals are studied. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which

depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals. E. S. Dana's Text Book of Mineralogy. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE ANALYSIS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and its accompanying apparatus and reagents. The student first studies the reactions of the elements with known minerals and then determines unknown minerals by the knowledge thus acquired. Brush and Penfield's Determinative Mineralogy and Blowpipe Analysis. *Sophomore—First and Second Semester.*

DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. E. S. Dana's Text Book of Mineralogy. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This branch of Geology treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarryman have to meet. Scott's Introduction to Geology. *Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's crust. *Scott's Introduction to Geology. Junior—First Semester.*

ECONOMIC GEOLOGY.—In this branch of study the uses and commercial value of rocks and ores are especially emphasized. A study is included of common rock and vein-forming minerals, origin of ore deposits, classification of ore deposits, study of deposits of iron, copper, gold, silver, lead, zinc, etc., and of coal, petroleum, etc., as well as a study of building stones, cements, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Kemp's Ore Deposits of the United States, and Tarr's Economic Geology. Junior—Second Semester.*

OPTICAL MINERALOGY.—This connecting link between Mineralogy and Petrography embraces a study of the principles of optics, including the propagation of light, total reflection, refraction, refractive indices, polarization, especially by means of the Nicol prism. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lenses, the camera lucida, and the preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form, crystalline texture, cleavages and parting, color in ordinary and in polarized light, relative re-

fringence, optic axes, axes of elasticity, positive or negative, and uniaxial or biaxial character, relative birefringence, extinction in parallel polarized light, character of interference figures, and dispersion. *Senior—First Semester.*

PETROGRAPHY.—This subject is treated so as to include a study of the classification and determination of igneous, sedimentary and metamorphic rocks, chiefly by the aid of the microscope. It is closely dependant upon the preceding course. It is accompanied by a brief study of a summary classification, and the methods used in determining rocks without the microscope. J. F. Kemp's Handbook of Rocks is used for the latter. *Senior—Second Semester.*

MICROCHEMICAL ANALYSIS.—The work in this subject is chiefly in the laboratory, and consists of a study of the methods of determination of the various elements and minerals by chemical reactions with minute quantities under the microscope. Behrens' Manual of Microchemical Analysis. *Senior—Second Semester.*

MECHANICS.

PHYSICS.—The subject of Mechanics begins in the Sophomore year with a course in general physics. During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are introduced giving prominence to their practical aspects. Aside from the nature and measurement of heat, its application to the steam-engine and the transmission of energy by means of compressed air are consid-

ered. The work in light includes a study of optical and engineering instruments and of the phenomena presented in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc. During this semester the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light are determined and familiarity with simple electrical measurements is acquired.

ANALYTICAL AND APPLIED MECHANICS.—These subjects are introduced in the Sophomore year in connection with drawing. The mechanism of machinery, mechanical movements and the modes of communicating motion will be studied.

During the Junior year the analytical and applied mechanics will have application to the proportioning of materials in engineering and mechanical structures. Many problems are solved during this course and applied in the machine designing which follows throughout the same year.

GRAPHICAL STATICS.—The object of this course is to teach the theory of graphical analysis of stresses in structures. A considerable part of the time is spent in the drawing room solving problems, analyzing trusses, etc.

HYDRAULICS.—The course in hydraulics includes a study of problems connected with the storing and conveying of water, the structure of dams, water-wheels, etc.

TESTING LABORATORY.—The work in the Testing Laboratory is designed to cover experimentally the formulas derived in the courses in mechanics as applied to various materials of construction. The elastic properties and strength of materials is also investigated.

POWER TRANSMISSION.—The transmission of power by means of compressed air, electricity, steam and other devices including the machinery involved is taken up in this course.

ELECTRICAL ENGINEERING.—The first two years of the electrical engineering course are identical with the first two years of the mining engineering course. During the Junior year the student pursues an extended course in the electrical laboratory. For this purpose an equipment has been provided consisting in part of galvanometers, resistance boxes, wheatstone bridges of various forms, condensers, induction coils, electro-dynamometers, ammeters, voltmeters, keys, switches, etc. A storage battery is furnished for use in this department. The student also makes a study of the telegraph and telephone systems and the elementary theory of the dynamo.

The electrotechnical work of the Senior year consists of designing, the theory of alternating currents, electric lighting and photometric work, power transmission and electrical testing in the dynamo laboratory.

The dynamo laboratory is equipped with a twelve-horse-power gas-engine running a line shaft from which are belted, direct and alternating current dynamos. Motors, transformers and the requisite measuring instruments are also provided. The shop is at present provided with a complete line of bench tools, a thirteen-inch lathe, and

emery wheels. Shafting and room are provided for extending the equipment of this department as soon as practicable.

The advantages of the electrical engineering department are offered to mining engineering students who wish to become proficient in this line of work in connection with the regular mining course, the work chosen being subject to the approval of the faculty.

MINING AND MINING ENGINEERING.

MINING.—Instruction in this subject includes the study of methods of exploration, sinking of shafts, drifts, tunnels, adits, boring, breaking ground, blasting, drilling, hygienic conditions and mine examination.

MINING ENGINEERING.—This subject embraces the methods of mining, timbering, hoisting machinery and operations, application of electricity and water-power, compression of air, underground traffic, surface transportation, pumping, ventilation and illumination.

SURVEYING.—Field practice in surveying occupies six weeks in both the first and third summer vacations, during which the student gives his whole time to the subject. There will be practice in the use and adjustment of instruments, land, mine and geological surveying, leveling and triangulation. The courses also include practical work in topographical drawing and map construction.

Preliminary to each of the above courses, the student spends a part of one semester in the study of the theory involved in the practice.

DRAWING.—During the first year the work in drawing consists in making elementary projections descriptive geometry, working and isometric drawing of machinery furnaces, structural work, tracing and blue printing. The drawing required during the remainder of the course is connected with allied subjects as machine designs, mine surveying, etc. Topographical and geological maps will be constructed during the course.

EXCURSIONS.

To secure a more thorough practical acquaintance with the subjects taught in the School of Mines, frequent excursions will be made during the progress of the school year to some of the extensive mining and metallurgical plants in the vicinity of the school. These excursions will be under the direction of a professor or other officer of the school, who will give explanatins of the machinery-constructions and processes employed in the various plants. In addition to these short excursions taken in term time two long excursions for practice in engineering will be required during the four-year course.

The first of these will be made at the close of the Freshman year by the class in engineering and will continue for six weeks, during which the class will be exercised in the use of instruments and the ordinary work of surveying and leveling.

The second will also continue for six weeks and will be made at the end of the Junior year.

During this excursion attention will be given mainly to mining and mining engineering.

Every candidate for a degree must attend these excursions.

EQUIPMENT.

The equipment of the School of Mines here described has been secured through the appropriation for that purpose of the sum of \$15,000 by the legislature of 1899. This money was mainly spent in securing the apparatus and appliances necessary for the successful prosecution of the work of the Freshman and Sophomore classes. The legislature of 1901 made a further liberal appropriation which is available during the years 1901-1902 for the increase of this equipment. From this latter source purchases are now being made which will still further facilitate the work of the lower classes and at the same time make suitable provision for the accommodation of students in the Junior and Senior years of the course. The list, which follows, is by no means complete, but it will serve to indicate the general line of policy that has been adopted in this department of the work.

CHEMICAL DEPARTMENT.—The Chemical Laboratory is equipped with the most modern style of student's desk. Each desk is provided with shelves for holding reagent bottles and glass cases to protect unfinished work from accident and dust. Drawers and cupboards are provided underneath the desk for holding apparatus not in use, having a single lock, without duplication, so that all the student's material is under his absolute control. There is also space for holding aprons, towels, etc. The tops of the desks are finished in glazed white tile and each individual desk has a sink, water and gas. On one side of the Laboratory is a tile-topped table for blast-lamp and combustion work. The laboratory is provided with two com-

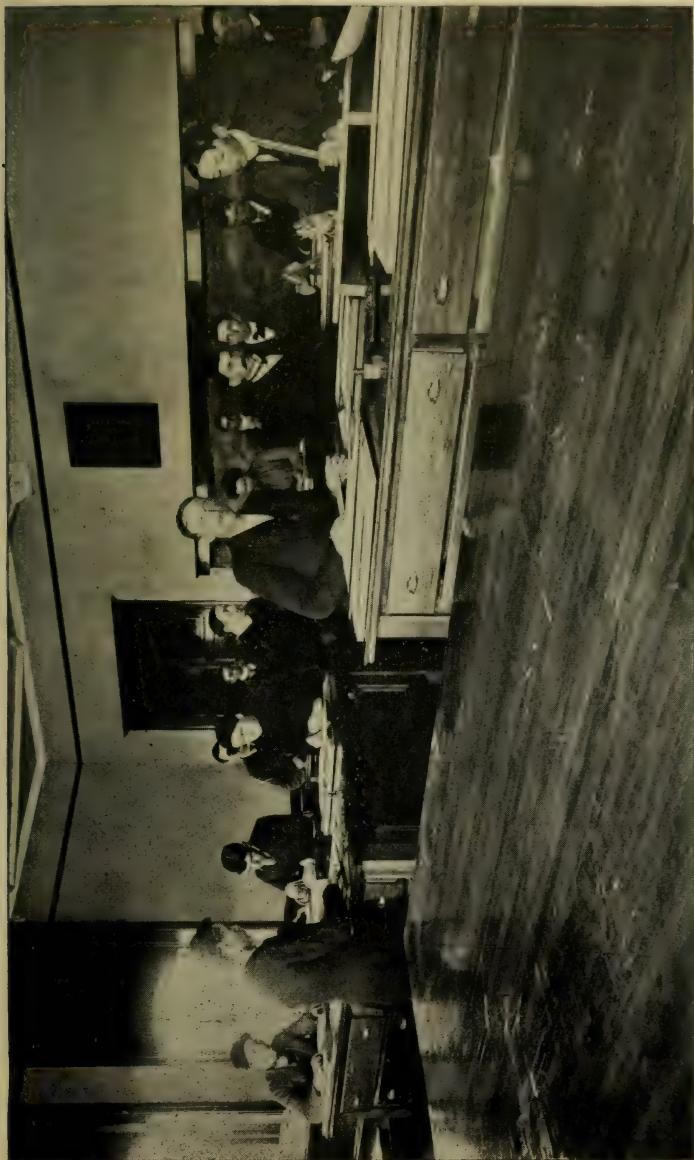
modious chemical hoods to carry away all noxious gases, the hoods also being supplied with hot-plates, air-baths, steam evaporating pans and hydrogen sulphide apparatus. All ordinary chemicals for the use of the student are placed on side shelves. An electrolytic case is placed conveniently in the laboratory for the use of the student, the current of which is supplied from a storage battery. Bunsen filter and exhaust pumps, for rapid filtration, are placed at the convenience of the student.

The balance-room adjoins the chemical laboratory, being supplied with analytical and gold balances upon a table supported by piers constructed independent of the building, so that vibration is reduced to a minimum. In this room is also located a dark-room for spectroscopic work.

The chemical lecture-room adjoins the general laboratory on the side opposite to that of the balance-room. It accommodates forty-eight students and this capacity can be increased if the occasion requires. The chairs are placed upon terraces and are provided with arms convenient for taking notes. A glass case on the side of the room holds the apparatus for lecture purposes. The demonstrating table is tile-topped and is provided with pneumatic trough, gas, blast, water, hydrogen, oxygen and an alternating and direct current of electricity up to 750 volts and 45 amperes. A hood backs the demonstrating table to carry off noxious fumes and is provided with a hot-plate, gas, blast and water for distilling purposes.

The private chemical laboratory is equipped with all modern conveniences for carrying on analytical work; having a chemical hood, working table, side tables, glass cases, shelves, electrolytic case, blast and combustion table

GENERAL LIBRARY
MONTANA
STATE SCHOOL OF MINES



DRAWING ROOM

with tile top, and the room is abundantly supplied with water, gas, blast, hydrogen, oxygen, electricity and conveniences for fractional distillation. In this room all chemical reagents are prepared for the use of the student; check analyses are made on his work; and all public analyses and assays are made by the instructor in charge. The adjoining room is the office containing the analytical and gold balances, protected from the fumes of the Laboratory. A dark-room also adjoins for carrying on photographic work, spectroscopical analysis, making blue-prints, lantern slides, etc.

METALLURGICAL DEPARTMENT.—The Assay Laboratory is supplied with the most modern gas assay furnaces which, on account of their freedom from coal, ashes and soot, make them especially desirable for this work. Their ease of operation gives the student a better chance to study the all-important effects of change of temperature, and the furnaces being completely under the control of the operator, when once he learns the proper heat necessary for carrying on a given operation, he can, at any time, secure that same temperature and sustain it absolutely for any length of time. For cupellation these furnaces are superior.

This Laboratory also contains a gas melting furnace for melting and alloying metals, retorting amalgam and refining gold, silver and lead bullion. The pulp balances are also placed in this room, so that the student can weigh out his charges and watch his furnaces at the same time. The gold and silver balances being in the next room are away from the influence of the heat of the furnaces.

The ore-dressing room has a laboratory crusher and a grinder capable of pulverizing ore to 80 mesh. The power

for running these machines is furnished by a ten horse-power gas engine. There is also a buckboard and tables for rolling and sampling ores; sieves for grading ores from 10 mesh to 120 mesh; splitters, sampling pans and sampling apparatus. A high pressure blower is located in this room which furnishes an air blast for the gas furnaces, laboratories and lecture room.

The chemical and assay supply room is located next to the ore-dressing room and contains all the chemicals and apparatus necessary for carrying on the work of the laboratories. It is the intention of the School to have in stock a sufficient supply to last a year, and if at any time any articles are exhausted they are immediately replaced.

GEOLOGY AND MINERALOGY.—The Department of Geology and Mineralogy occupies three rooms on the second floor and two on the third floor. The lecture room, which is in the southeast corner of the building, has a seating capacity of about seventy-five. The mineralogical laboratory is well lighted by windows on three sides; it occupies the southwest corner of the building, and is equipped for thirty-six students at one time. Each student has separate desk room, separate drawers, separate apparatus, reagents, etc. Gas is supplied to each student, and water pipes and sinks are conveniently placed about the room. For the general use of the class an analytical balance, a Jolly balance, a Westphal balance, a hood, and several series of minerals are provided. Thus, besides the large collection of minerals for ordinary blowpipe determinations, the department has a series of minerals classified according to the bases present, another series systematically arranged in the Museum according to the chemical composition, and

several other series are placed in the laboratory, convenient for reference or study at any time, which illustrate the various physical characters of minerals, such as hardness, specific gravity, structure, fusibility, color, luster, etc.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Penfield goniometers for personal use; the department has, further, two sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The office and supply room occupies the center of the south side of the building. The department is rapidly building up a good working library of books on mineralogy and geology, and it receives all the important American and foreign periodicals devoted to these sciences. Complete sets of some American journals especially devoted to economic and general geology have been obtained, as well as many valuable official geological reports. The students are invited and urged to become familiar with current scientific literature.

The elaborate mine models in the Museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

Two series of fossils have been obtained, one representing all geological horizons, chiefly from classic European localities, and the other a series from the Tertiary basin of Paris, France. Additions from important American localities are being received.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are operated by means of the gas engine; each student is expected to learn to make his own thin sections of rocks. At the same time several series of thin sections already prepared are available for study, and the latest model large size Nachet microscope is employed for the microscopic examinations. All the useful accessories for this work are at hand, including the Bertrand lens, the Fedorof inclining stage, the Michel Levy comparateur, the Lacroix axial goniometer, and a microphotographic apparatus. In order to permit ready and convenient use of the last a large dark room has been fitted up in the third story; it serves also for goniometric practice.

The Museum, which occupies a large room on the first floor, contains three mine models, a systematic collection of minerals, the Ward collection of rocks illustrating geologic phenomena, a series of fossils from the Tertiary of the basin of Paris, a specimen of copper glance from the Never Sweat mine, weighing nearly two tons, and a collection of ores of commercial importance.

PHYSICS.—The Department of Physics occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons and is provided with modern lecture-room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy table and apparatus for the measurement of physical constants. Among the measurements that may be made in the domain of mechanics and heat may be mentioned, measurements of density, elasticity, the force of gravity, the latent heat of fusion and of evaporation, specific heats, verification of Boyle's law, etc. For the measurements in electricity, galvanometers, resistance boxes with the necessary batteries, keys, etc., are provided.

For the work in light there is provided a spectrometer and an optical bank together with lenses and attachments for the measurement of focal lengths and for constructing telescopes and microscopes.

ELECTRICAL APPARATUS.—In the basement of the building a dynamo room is provided with an eleven-horse-power gas engine from which are belted direct and alternating current dynamos. A switch-board connects these machines with lines running to various parts of the building. A storage battery of ten cells is also connected to the switch-board. For the purpose of making measurements there is provided a collection of Weston volt and ammeters for both direct and alternating currents, rheostats, dynamometers, etc. The electrical laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated

electrical measurements. In connection with this laboratory there is a small shop equipped with a thirteen-inch screw-cutting lathe and a set of hand tools for wood and metal working.

ENGINEERING.—The drafting rooms occupy two large and well lighted rooms on the second floor of the building. At present there are accommodations for seventy-two students in drawing.

The principal instruments for carrying on the work in surveying are: One complete mountain and mining transit, made by Buff & Buff; one complete engineer's transit with solar attachment, by C. L. Burger & Sons; one complete engineer's transit, by Gurley; two levels and one sextant, by Gurley. Besides these instruments there is a collection of rods, poles, chains, tapes, etc., necessary in carrying on the work of the department.

MAGAZINES.

The following scientific magazines will be found on the Library tables, and in the rooms of the members of the faculty, where they may be freely consulted by the students:

Engineering and Mining Journal.	American Chemical Journal.
Mining and Scientific Press.	Chemical News.
Engineering News.	Berichte—Leipsic.
Electrical World and Engineer.	Journal of Geology.
Columbia School of Mines Quarterly.	American Geologist.
London Electrician.	Bulletin American Geological Society.
Philosophical Magazine.	Geological Magazine (London.)
Nature.	Zeitschrift fur Krystallography.
American Journal of Science.	Neues Jahrbuck fur Mineralogie,
Science.	Geologie and Palaeontologie.
American Journal of Mathematics.	Petrographische und Mineralogische Mittheilungen.

Bulletin de la Societe Francaise
de Mineralogie.

Bulletin de la Societe Francaise
de Geologie.

Quarterly Journal of the Geologi-
cal Society.

Annalen der Physik.

Comptes Rendus.

Annales de Chemie et de Phy-
sique.

Transactions of The American
Institute of Mining Engineers.

The following newspapers are kindly furnished by their
publishers, free of charge:

Helena Herald (Daily), Helena.

The Missoulia (Daily), Missoula.

Great Falls Leader, (Daily), Great
Falls.

The Blue Mountain American
(Weekly), Baker City, Ore.



DONATIONS.

A complete record of all donations received by the School of Mines is kept at the Institution in permanent form. The following is a summary list of gifts received from the establishment of the School to the 15th of May, 1901.

Official geological and scientific reports have been received from,

E. J. Babcock.. State Geologist	Grand Forks, N. D.
E. H. Barbour State Geologist	Lincoln, Neb.
A. E. Birge.... Director, Geological Survey.....	Madison, Wis.
W. S. Blatchley.. State Geologist	Indianapolis, Ind.
John Byrne ... Inspector of Mines	Helena, Mont.
Samuel Calvin. State Geologist	Iowa City, Ia.
W. B. Clark.... State Geologist	Baltimore, Md.
A. S. Cooper State Mineralogist	Sacramento, Cal.
C. H. Crantz.. State Geologist	Springfield, Ill.
G. M. Dawson. Director, Geological Survey.....	Ottawa, Ont.
A. T. Dunn..... Surveyor-General	St. Johns, N. B.
J. A. Ferguson. Commissioner Agriculture, Labor and Industry	Helena, Mont.
Leo Gallaher .. Acting State Geologist	Jefferson City, Mo.
T. W. Gibson.. Acting Director, Bureau of Mines..	Toronto, Ont.
Edward Gilpin. Inspector of Mines.....	Halifax, N. S.
Erasmus Haworth Geologist, University Geological Survey	Lawrence, Kans.
C. L. Herrick.. President, University, New Mexico	Albuquerque, N. M.
A. C. Lane.... State Geologist	Lansing, Mich.
H. A. Lee..... Commissioner of Mines.....	Denver, Colo.
J. Obalski Inspector of Mines	Quebec, Quebec.
W. M. Robertson. Provincial Mineralogist	Vancouver, B. C.
..... Secretary of State.....	Austin, Tex.
F. J. V. Skiff.. Director, Field Columbian Museum	Chicago, Ill.
E. A. Smith.... State Geologist	University, Ala.
J. C. Smock... State Geologist	Trenton, N. J.
W. C. Stubbs.. Director Agricultural Experiment Station.....	Baton Rouge, La.
B. H. Tatem... Assayer, U. S. Assay Office.....	Helena, Mont.
J. E. Todd.... State Geologist	Vermilion, S. Dak.
N. H. Winchell State Geologist	Minneapolis, Minn.



LECTURE ROOM—CHEMISTRY

Books, pamphlets, maps, etc., have been received from,

C. W. Goodale..	Superintendent B. and M. Smelter,	Great Falls, Mont.
U. S. Grant.....	Professor of Geology, Northwestern	
	University	Evanston, Ill.
Harper &		
Macdonald.....	Civil Engineers	Butte, Mont.
G. W. Irvin.....	Postmaster	Butte, Mont.
N. R. Leonard..	President Montana School of Mines....	Butte, Mont.

Mineral, ore, and geological specimens have been received from,

Anaconda Copper Mining Company....	Butte, Mont.
Boston and Montana Consolidated	
Copper and Silver Mining Company..	Butte, Mont.
Butte and Boston Copper Mining	
Company.....	Butte, Mont.
H. S. Clark.....	Butte, Mont.
S. H. Crookes.....	Livingston, Mont.
John Gillie	Butte, Mont.
C. W. Goodale.....	Great Falls, Mont.
I. M. Jones	Butte, Mont.
N. R. Leonard..	Butte, Mont.
Montana Ore Purchasing Company....	Butte, Mont.
F. O. Nelson.....	Butte, Mont.
H. C. Packer	Hamilton, Mont.
Reynolds & McDowell.....	Butte, Mont.
Eugene Ring, Jr.....	Butte, Mont.
W. H. Weed	Butte, Mont.
C. E. White	Butte, Mont.
E. H. Wilson	Butte, Mont.
A. N. Winchell	Butte, Mont.
H. V. Winchell	Butte, Mont.
W. F. Word	Butte, Mont.

Samples of steel tubing, etc., have been received from,

John Ryerson	Chicago, Ill.
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The Niagara Mining Company has presented to the Museum of Geology and Mineralogy of the School the model of the Niagara and Black Rock mines, constructed by R. C. Brown, and used in the famous Black Rock-Niagara suit some years ago. This model has been held in trust for the School of Mines, since the settlement of the case, by C. H. Moore of Butte, Mont.

The Colusa Parrot Mining Company has presented to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the lawsuit with the Anaconda Company, which was tried about a year ago. These models form an extremely valuable means of instruction, presenting, as they do, a graphic and easily understood picture of the workings and geological features of the mines in question.

The Anaconda Copper Mining Company has presented to the Department of Geology and Mineralogy a rock cutting machine and a rock grinding machine, both of large size and in first class condition. The gift includes, also, a complete set of accessories, such as Canada balsam, glass slides, cover glasses, several sizes of emery, etc.

Mr. C. W. Goodale, of Great Falls, Montana, has presented to the Museum his large collection of ores and minerals from various parts of the West and from Europe. This donation probably includes a thousand specimens some of which it would be very difficult to replace; it furnishes a good beginning for the working collections of ores of the School.

The Anaconda Copper Mining Company has presented to the Museum a specimen of chalcocite ore from the thirteen hundred foot level of the Never Sweat mine which weighs approximately thirty-five hundred pounds. It is, without doubt, the largest specimen of its kind on exhibition in the world. It formed the chief feature of the exhibit of the Company at the Omaha Exposition whence it was brought and installed at the School wholly at the expense of the Anaconda Company. This gift is accompanied by a series of samples illustrating the treatment of the

ore at the concentrators and smelters of the Company at Anaconda, Montana.

Mr. C. W. Clark, of Butte, Montana, has loaned to the Museum a remarkably well chosen collection of crystallized gold specimens. This collection has not yet been placed in the Museum on account of the lack of a safe or vault in which it may be securely kept. It was exhibited at the Columbian Exposition at Chicago in 1893, where it was awarded a medal.

EXPENSES.

FEES.—By the Act establishing the School of Mines no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other States or countries will pay a tuition fee of \$25.00 per semester, or (\$50.00) per year.

A registration fee of \$5 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.—To secure the State from loss for apparatus that may be broken by the student, a deposit will be required of each one, engaged in laboratory work, at the opening of the year. This deposit will be placed in the hands of the Treasurer of the Board of Trustees. Each student will be charged with the apparatus that may be issued to him. At the close of the year he will be credited with such articles as he returns in good order. The balance of this account will be deducted from his deposit, and the remainder will be returned to him.

The following is the list of deposits that will be required :

Mineralogy	\$10
General Geology	2
Petrography and Microchemical Analysis.....	25
Freshman Chemistry	15
Quantitative Analysis	20
Assaying	25

If at any time before the close of the year the breakage amounts to the sum deposited, a new deposit will be required.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the city of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. Those who find it necessary to economize can avail themselves of opportunities for doing so, similar to those they could find elsewhere.

PUBLIC ASSAYS.

By the laws of Montana the professor of Metallurgy and Assaying is permitted to make assays for private parties who may apply therefor, but he is required to make such charge for this work as may be fixed by the Board of Trustees. The fees thus paid are to be turned in to the hands of the treasurer of the School. No such assays will be permitted to be made in the Institution except by the professor in charge.

GENERAL INFORMATION.

The city of Butte is universally known as the great mining center of the country, but the day has passed when it is only this and nothing more. Every year brings a large accession of population in which the best and most intelligent classes of the country are largely represented. Its public schools are in a flourishing condition, and no where is there a larger attendance in proportion to the population of a school age than here. The Butte which was known a few years ago as only a great mining camp, with a somewhat restless, roving population, living and doing business in rude or temporary quarters, has given place to the modern city, with spacious business blocks, halls, libraries, elegant churches, and many hundreds of residences such as would do credit to any city of its size anywhere. The moral and intellectual atmosphere of the place is such as to make it a desirable place for the location of a modern institution of learning.

The special advantages of the city as the home of a School of Mines grow out of the fact that here, as in no other place in the world, the mining student can obtain from actual observation, a practical acquaintance with all the latest processes in mining and the reduction of ores.. There is scarcely a process in any branch of mining or metallurgy known to the Northwest that may not here be seen in operation, or machinery of any recognized value that is not here employed.

The mining companies, their officers and employes, all feel a personal interest in the School, and every facility is freely offered for all proper exploration or examination of

the mines and smelters that abound here and in this immediate vicinity. When it is known that the city of Butte furnished last year nearly one-fourth of the entire copper product of the world, beside many millions of dollars worth of silver, gold and lead, the magnitude of its mining enterprises will be partially understood. There is every indication that its relative importance as a mining center will increase in coming years. The large area known to be rich mineral ground is growing larger, and its rich ledges of ore are each year being traced down to lower levels. The development already made has in large measure only scratched the surface of things, while the full revelation of its wealth of resources is reserved for generations yet to come.

The friends of the School of Mines are confident that with such an environment it will soon become one of the most important institutions of its kind in the country. The management of the School confidently invites the patronage of those who desire the education of a mining school either for themselves or their children.



CATALOGUE OF STUDENTS FOR THE COLLEGIATE YEAR 1900-1.

FRESHMAN CLASS.

Albee, William M.....	Deer Lodge.
Balmforth, Alfred J.....	Butte.
Caulfield, Thomas	Butte.
Christie, D. E.....	Butte.
Cosgrove, J. P.....	Butte.
Farnham, Leroy S.....	Butte.
Foster, Rollins S.....	White Sulphur Springs.
Gallagher, Frank M.....	Butte.
Harnan, Will L.....	Butte.
Irelan, A. L.....	Helena.
Little, Isabel	Butte.
MacRae, L. D.....	Anaconda.
McGee, John	Butte.
McGuane, Harry	Butte.
Pauley, P. L.....	Basin.
Tallant, Harry S.....	Butte.
Wilcox, A. L.....	Butte.

SOPHOMORE CLASS.

Bender, Louis V.	Butte.
Clark, Clara	Butte.
McClintock, Saxe M.....	Butte.

JUNIOR CLASS.

McGeehan, Paul	Butte.
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SPECIAL COURSES.

Avery, Herbert B....	Chemistry	Butte.
Bowden, William H..	Drawing	Butte.
Gray, Bert B.....	Chemistry and Metallurgy.....	Butte.
(A. B. Iowa College.)		
Harris, S. K.....	Mineralogy, Mathematics, Physics and Chemistry.....	Butte.
Hewitt, Merton A....	Mathematics.....	Butte.
Humphreys, H. J....	Mathematics and Engineering.....	Albany, Iowa.
Kuphal, Henry	Mineralogy, Mathematics, Drawing	Butte.
Mullany, Martin ...	Chemistry.....	Butte.
Schmidt, John S....	Chemistry	Butte.
Weed, Mrs. Helen H	Physics and Mineralogy.....	Butte.

PREPARATORY.

Archibald, George	Butte.
Hume, Harry G.....	Meaderville.
Grant, James F.....	Centerville.
Kirby, Kenneth P.....	Butte.
Mayer, Edward	Butte.
Murphy, Emmett	Butte.
Payne, Thomas	Butte.
Warfield, Herschel	Butte.

Total 39

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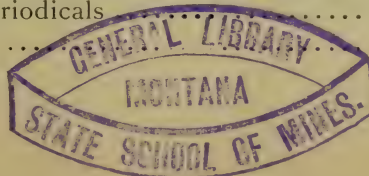
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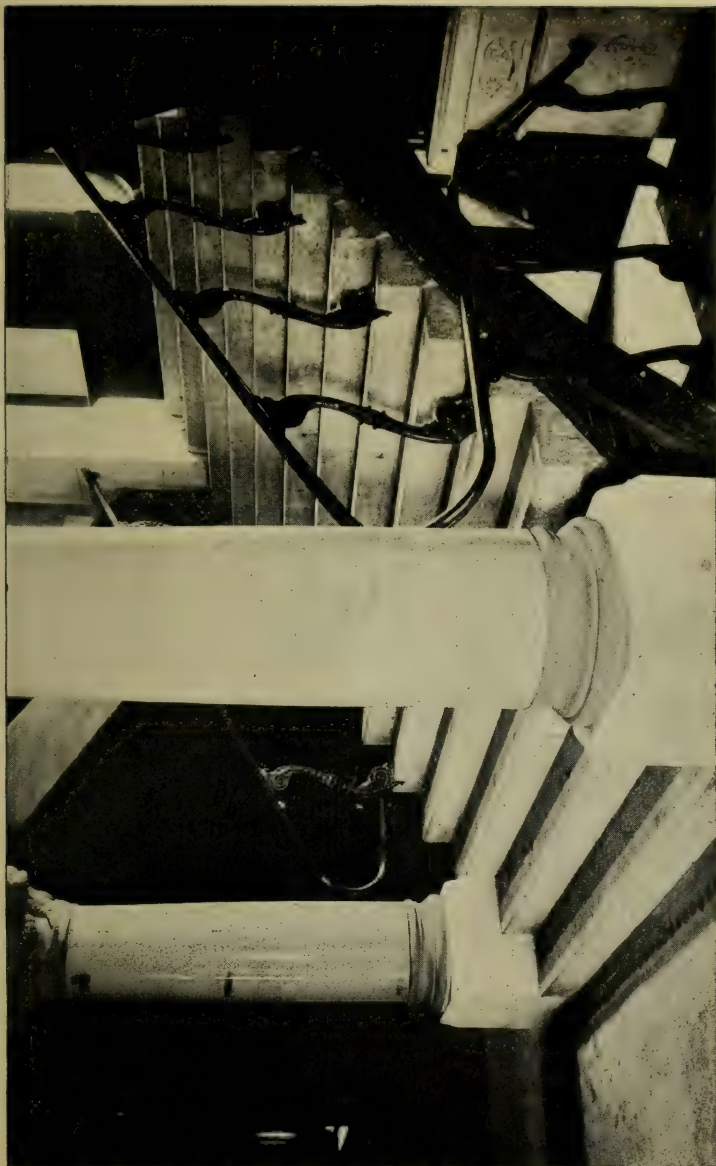
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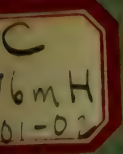
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2090
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MAIN STAIRWAY



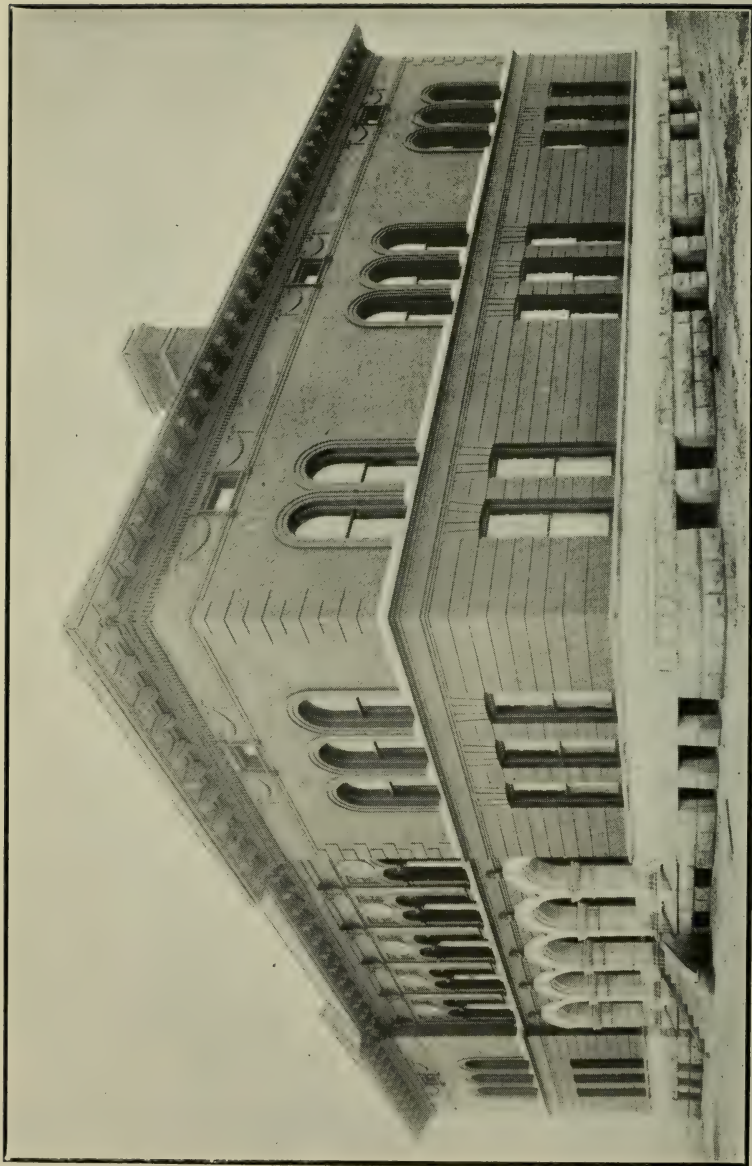
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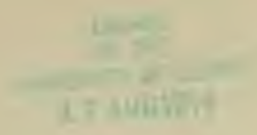
MONTANA
STATE SCHOOL
OF MINES

1901-1902

BUTTE, MONTANA



STATE SCHOOL OF MINES.



Montana

State School of Mines

BUTTE



Second Annual Catalogue of the
OFFICERS and STUDENTS
For the Year 1901-1902
With announcements for the Year 1902-1903



BUTTE, MONTANA.

Calendar for 1902-3.

1902.

September 8—Entrance Examinations.

September 9—First Semester begins.

November 27—Thanksgiving—Holiday.

December 19—Holiday Recess to January 5, 1903.

1903.

January 22—Term Examinations begin.

January 23—End of First Semester.

January 27—Second Semester begins.

June 4—Term Examinations begin.

June 5—End of Second Semester.

June 9—Summer Field Work in Surveying begins.

July 21—Summer Field Work in Surveying ends.

1903-4.

September 8—First Semester begins.

Montana State School of Mines.

HISTORICAL SKETCH.—The foundation for the Montana State School of Mines was laid in the "Enabling Act" in pursuance of which the States of North and South Dakota and the States of Montana and Washington were admitted into the Union.

This Act made an appropriation of forty thousand acres of public land to each of the Dakotas, and one hundred thousand acres to the State of Montana for the establishment and maintenance in each of a State School of Mines. This was the first step taken by our national government for the promotion of institutions devoted to the education of the youth of our country in the specialties that relate to the mining industry. It came as the natural sequence of the Morrill act of 1862, which provided for the establishment of state schools for instruction in agriculture and the mechanic arts. Every state in the Union has organized at least one school under the Morrill act, and the experience of a quarter of a century has shown substantial benefits accruing to the states and the country at large from the adoption of that policy.

The great development of the mining industry in the years immediately following the civil war, and especially the wonderful discoveries of the precious metals in the mountain states of the West gave to the calling of the miner an importance that attached to no other avocation save that of the farmer. It was easily seen that for the successful prosecution of his work the miner still more than the farmer was in need of a special education in the sciences that stand related to his avo-

cation and to the occurrence of ores, and their extraction and proper treatment. It required no profound investigations in political economy to show that the prosperity of all our people was a result in which the prosperity of the miner was a most important factor.

It was on Washington's birthday in 1889 that this "Enabling Act" received the signature of the President of the United States. By this act our government became committed to the policy of promoting schools whose special purpose it should be to educate the rising generation in those branches that tend to fit them to be theoretical and practical miners.

In due time these three states availed themselves of the provisions of the act of 1889. The State of Montana promptly accepted the donation of lands for a School of Mines, and appointed officers to select the amount allowed by the government, and the legislature of the state determined to have the School of Mines established and put in operation as soon as the necessary preliminaries could be arranged. It chose the city of Butte, the great mining center of the state, as the location for the school and appointed a commission consisting of five persons to prepare plans and specifications for the erection of buildings for its accommodation, and to contract for and supervise their construction.

This commission was composed of Hons. F. E. Sargeant, John Gillie, W. W. Dixon, J. H. Leyson and Charles W. Goodale.

The plot of ground upon which the School of Mines building was erected is made up of portions of the Mint lode, donated for the purpose by Gen. Charles S. Warren; the Vanderbilt lode, donated by Messrs. George H. Casey, Levi J. Hamilton, R. H. Wearing, Joseph R. Silver and Robert A. Day; and of the Montrose Addition, donated by Henry Haupt and others. The dimensions of this plot are 376 feet in breadth by 500

feet in length. It is located about 80 rods west of the western boundary of the city on the southern bench of "Big Butte." The situation commands a fine view of the city and surrounding country and with the early completion of the city railway will be easy of access to the mining, the business and the residence portions of the city.

The School of Mines building was erected in 1896-7. Its dimensions are 94 feet by 118. It is three stories in height, with a spacious unfinished attic which is practically equivalent to another story. The foundation story is of stone. Those above are of brick. It is nearly, but not absolutely fire-proof. The floors of the lower or basement story are of cement. The stairways are of stone resting on stone pillars and arches of brick. The halls are floored with tile laid in cement and metallic lath were used in plastering. The plan of the building was well conceived, and it is often spoken of as the most substantial public structure in the state. No part of the expense for the erection of this building was borne by the state. The legislature authorized the issue and sale of thirty-year bonds to the amount of \$120,000. These bonds bear interest at the rate of 5 per cent, and are redeemable after fifteen years. The state pledges the donated lands and all the income derived in any way therefrom to the redemption of these bonds, and further pledges itself to make good any deficiencies in the payment of interest, charging back, however, any sums that may be thus advanced to the landed endowment of the institution. The bonds were sold at par August 20, 1900. The moneys that had been needed from time to time in the erection of the building were advanced by citizens of the city and state, and these moneys have now been refunded, or are being refunded, from the proceeds of the bond sale.

At its session in 1899 the state legislature appropriated \$26,300 for the equipment of the building and for the mainte-

nance of the school up to the close of the fiscal year, November 30, 1900. The larger part of this sum was used in the purchase of furniture and scientific apparatus. In making these purchases it has been the declared purpose of the management that everything obtained should be of the best quality and of the most modern construction.

At its session in 1901 the legislature made a further appropriation of \$57,861.77 to add to the equipment and for the maintenance of the institution for the two years ending November 30, 1902.

The School of Mines was first opened for the reception of pupils September 11, 1900. A large number of young people desired admission, but as it was not permissible to open a preparatory department, four-fifths of these requests had to be refused for lack of sufficient educational preparation. As many of those who were thus refused admission were worthy young men of mature years, many of them having more or less practical experience in mining, it was felt that something ought to be done to favor this class of persons in the future. After consultation with the State Board of Education an arrangement was made whereby those who are prepared to take up some lines of work in the school may be admitted and at the same time receive instruction in preparatory studies.

The total number admitted during that year was 39. According to printed statistics this is a larger number than was secured by any similar institution during the first year of its existence. The Michigan School of Mines reports only 23 students for its first year, 29 for its second, and 40 for the third year. The Colorado School of Mines had an equally humble beginning.

During this, its second year, the attendance has increased to 94, to-wit: 62 in the day school and 32 who attend the night sessions.

The demand for a School of Mines in this, the "Treasure State," is very urgent, and as soon as our preparatory and high schools are well established and doing their appropriate work the number of pupils that will come hither from Montana alone will severely tax the resources and accommodations that this institution will have at its command.

FINANCIAL RESOURCES.

The financial resources of the institution consist of the legislative appropriations, which, for the last two years, have been \$25,000 per year for equipment and maintenance, and the congressional grant of 100,000 acres of land for "the establishment and maintenance of a School of Mines."

At the close of the fiscal year, November 30, 1901, 96,744.24 acres of the land grant had been selected, of which 96,344.24 acres had been patented to the state. The character of the land is thus described:

	Acres.
Timber land	27,516.28
Agricultural land	1,501.80
Grazing land	67,726.16
Total	96,744.24

The timber land is estimated to contain 110,985,000 feet of saw timber, valued at \$2.00 per thousand feet; no timber has yet been sold

Only 214.24 acres of the entire grant has been sold. The proceeds of the sale amounted to \$2,314.96, or an average of \$10.80 per acre.

The Land Commission has leased 59,153.36 acres, which during the fiscal year yielded a rental of \$6,222.23.

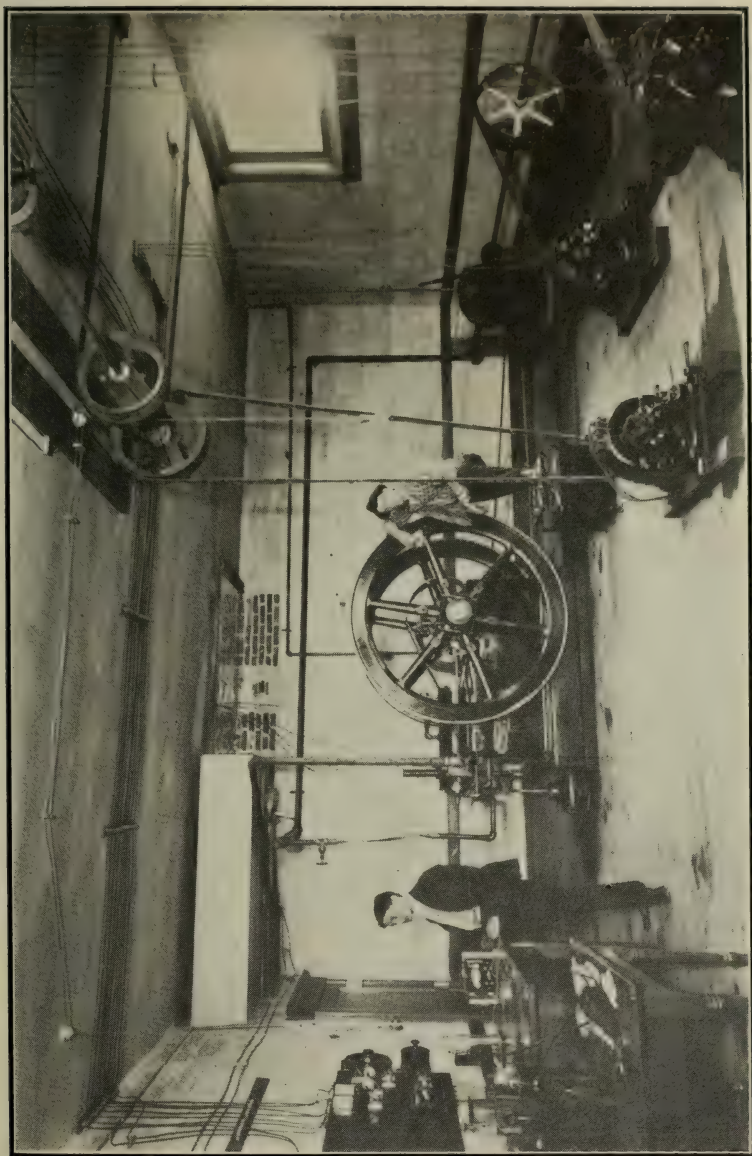
It will be seen that the state is entitled to select 3,255.76 acres more of public land on School of Mines account.

Against this land grant is to be charged the \$120,000 of outstanding bonds issued to erect the School of Mines building.

It is expected that the legislative appropriation for maintenance will be sufficient to defray the expenses for the balance of the year.

BOARDS OF CONTROL.

The general control of the higher educational institutions of the state of Montana is by our constitution, vested in the State Board of Education, subject to the laws of the commonwealth. This control, in the case of the School of Mines, is exercised through a local Board of Trustees.



ENGINE AND ELECTRIC MOTOR ROOM

STATE BOARD OF EDUCATION.

(Ex-Officio.)

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JAMES DONOVAN, Attorney General.

W. W. WELCH, Supt. Public Instruction.

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(Term Expires February 1, 1906.)JOHN M. EVANS.....Missoula
(Term Expires February 1, 1906.)G. T. PAUL.....Dillon
(Term Expires February 1, 1905.)N. B. HOLTER.....Helena
(Term Expires February 1, 1905.)J. G. MCKAY.....Missoula
(Term Expires February 1, 1904.)O. P. CHISHOLM.....Bozeman
(Term Expires February 1, 1904.)N. W. McCONNELL.....Helena
(Term Expires February 1, 1903.)WM. M. JOHNSON.....Billings
(Term Expires February 1, 1903.)

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COMMITTEE ON SCHOOL OF MINES.

W. M. JOHNSON.

C. R. LEONARD.

G. T. PAUL.

BOARD OF TRUSTEES.

JOHN E. RICKARDS.....	Butte
(Term Expires January 1, 1904.)	
GEORGE E. MOULTHROP.....	Butte
(Term Expires January 1, 1904.)	
WILLIAM A. CLARK, JR.....	Butte
(Term Expires January 1, 1904.)	
W. Y. PEMBERTON.....	Butte
(Term Expires January 1, 1906.)	
GEORGE H. ROBINSON	Butte
(Term Expires January 1, 1906.)	

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J. E. RICKARDS.....	Chairman
GEORGE E. MOULTHROP.....	Secretary
W. A. CLARK, JR.....	Treasurer
J. A. POORE	Stenographer

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President and Professor of Mathematics.

WILLIAM G. KING, A. M.,

Professor of Chemistry and Metallurgy.

ALEXANDER N. WINCHELL, Doctor Univ. Paris,

Professor of Geology and Mineralogy.

CHARLES H. BOWMAN, M. S.,

Professor of Mechanics.

*ALFRED B. KNIGHT, C. E.,

E. H. MacDONALD, M. E.,

C. W. Clark Professor of Mining Engineering.

JOHN B. CLAYBERG,

Lecturer on Mining Law.

CHARLES A. DIEHL, B. S.,

Assistant Professor of Chemistry.

LEON R. FOOTE, B. L.,

Instructor of the Preparatory Classes.

JOHN S. SCHMIDT,

Assistant in Chemical Laboratory.

JOSEPH ROBERT,

Janitor.

*Resigned May 1, 1902.

CONDITIONS OF ADMISSION.

The School of Mines is open on equal conditions to all residents of Montana without regard to sex or race, and to the youth of other states and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be sixteen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra to quadratics, plane geometry, geography, elementary zoology or physiology, physical geography and English composition.

NOTE.—After September 1, 1903, the age for admission to the Freshman Class will be seventeen years, and the requirements in mathematics will be so advanced as to include the first twenty-three chapters in Wentworth's Higher Algebra (or an equivalent) and the whole of solid and spherical geometry.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right, at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

Those who may be qualified for admission to some of the studies of the regular course, but are deficient in preparation for other studies, may be admitted and receive instruction under Professor Foote in those branches in which their preparation is deficient.

Graduates from the accredited high schools of the state will

be admitted without examination, on presentation of their diplomas.

LIST OF ACCREDITED HIGH SCHOOLS.

County High Schools:—

Beaverhead
Carbon
Fergus
Flathead
Gallatin
Jefferson
Park

City High Schools:—

Anaconda
Billings
Butte
Great Falls
Hamilton
Helena
Miles City
Missoula

PREPARATORY DEPARTMENT.

It has not been considered advisable to create here a general Preparatory Department similar to those connected with the other state schools of Montana. The School of Mines is to be maintained as a technical school and its energies confined within the sphere for which it was established. The general education of the youth of the state is provided for elsewhere. The character of the work done at the School of Mines makes it necessary that greater emphasis should be placed upon certain branches of preparatory education, especially those of a mathematical and scientific nature, than might be advisable in some other institutions.

The rule of the State Board of Education by which graduates of accredited high schools of the state are admitted, without examination, to the several institutions of higher education does not always insure a thoroughly prepared student, neither does an examination upon the subjects required guarantee that the applicant can pursue the courses successfully. To provide for such students and for others who come from localities where no schools fitting for college are maintained, the trustees have seen fit to establish a one-year preparatory course.

The subjects taught are those found on the following program of studies. The methods of instruction are similar to those employed in the school and are as practical as the nature of the subject demands. The aim is to make the work in this department so nearly like that of the school that the student may be fully equipped in manner of study and methods of thought so that he can do the work of the school successfully.

REQUIREMENTS FOR ADMISSION.

An applicant for admission to the preparatory department must be at least sixteen years of age, of sound bodily health and of good moral character.

He shall sustain a satisfactory examination in geography, algebra to factoring, and arithmetic, including the metric system. (Satisfactory to mean a grade of 75 per cent.)

In lieu of an examination an applicant may present a county teacher's certificate of Montana of equal grade, provided the certificate is in force.

PROGRAM OF STUDIES.

First Semester—

Algebra	5
Geometry, Plane	5
Physiology	3
English	3

Second Semester—

Algebra	5
Geometry, Plane and Solid.....	5
Physical Geography	3
English	3

(The numbers refer to the hours per week given to recitation.)

COURSE OF STUDY.

ALGEBRA.—Beginning at factoring, the year's work will conclude with the 23d chapter of Wentworth's Higher Algebra.

GEOMETRY, PLANE AND SOLID.—Four books of Wentworth's Plane and Solid Geometry will be completed by the close of the first semester, and four more by the close of the second semester, three of which will be in solid geometry. The student will be required to demonstrate nearly all the exercises found at the end of the first and second books and to write out his demonstrations in exercise books. Numerous other exercises are given throughout the year to illustrate the propositions demonstrated.

ENGLISH.—The work in this branch will continue throughout the year and will include composition, rhetoric and an introduction to English and American literature. Six compositions of 500 to 1,500 words each will be required during the year.

PHYSIOLOGY.—One semester of three hours a week is given to this subject. Twelve weeks will be given to the study of the human body, three weeks to biology, and three weeks to an introduction to paleontology.

PHYSICAL GEOGRAPHY.—Davis and Snyder's text is used, supplemented by readings from many other authors upon the subjects, as well as upon particular parts of physical geography. Excursions will be taken to ascertain the difference in temperature between the bottom and top of a mountain, the altitude of a mountain by means of a barometer, and to observe the waste of the land and other subjects suggested by the text. Observations will be taken and daily records kept of the temperature, of the direction of the wind, of the barometric pressure and of the kinds of clouds. The department is supplied with the daily weather report issued by the government.

COURSES OF STUDY AND DEGREES.

The course of instruction adopted for the School of Mines allows an election in the Junior and Senior years between certain studies, and for convenience these different lines of study are called, respectively, The Course in Mining Engineering and The Course in Electrical Engineering. Those who complete the first of these will be entitled to the degree of Mining Engineer (M. E.); those completing the second, to the degree of Electrical Engineer (E. E.). These courses are here given in tabular form; the figures following each topic represent the number of hours per week given to class-room or laboratory work in that topic.

COURSE IN MINING ENGINEERING.

FRESHMAN YEAR.

First Semester—

Higher Algebra	5
Geometry (twelve weeks).....	5
Plane Trigonometry (six weeks).....	5
General Chemistry	8
Drawing	9

Second Semester—

Spherical Trigonometry (four weeks).....	5
Analytical Geometry (fourteen weeks).....	5
Descriptive Geometry	4
Drawing	6
Qualitative Analysis	9
Summer Field Work in Surveying (six weeks).....	45

SOPHOMORE YEAR.

First Semester—

Analytical Geometry	5
Mineralogy	7
Physics	5
Quantitative Analysis—Laboratory	9
Mechanical Drawing	4

Second Semester—

Differential Calculus	5
Mineralogy	8
Physics	7
Quantitative Analysis	9
Drawing	3

JUNIOR YEAR.

First Semester—

Integral Calculus	5
Geology	5
Mechanics	2
Metallurgy—Lectures and Recitation.....	3
Machine Design and Drawing (half semester).....	9
Assaying (half semester).....	9

Second Semester—

Economic Geology	5
Metallurgy—Lectures	3
Metallurgy—Laboratory	9
Graphical Statics	5
Mine Surveying	2
Mechanics	5
Summer Field Work in Mine Surveying (six weeks)...	45

SENIOR YEAR.

First Semester—

Metallurgy	4
Petrography	7
Mining	5
Hydraulics	5
Mining and Metallurgic Design.....	6
Testing Laboratory	3

Second Semester—

Metallurgy—Lecture and Excursions.....	5
Mining—Lecture and Excursions.....	5
Power Transmission	3
Mining Engineering	3
Petrography	3
Mining Law—Lecture	1
Microchemical Analysis	1
Thesis	9

COURSE IN ELECTRICAL ENGINEERING.

(The Freshman and Sophomore years are the same as those of the Mining Engineering Course.)

JUNIOR YEAR.

First Semester—

Integral Calculus	5
Dynamo Machinery	3
Electrical Laboratory, half semester.....	9
Machine Design and Drawing, half semester.....	9
Mechanics	2
Electrical Measurements—Laboratory	9

Second Semester—

Economic Geology	5
Dynamo Machinery	3
Electrical Design	3
Electrical Measurements—Lecture	1
Electrical Measurements—Laboratory	9
Electrical Engineering	2
Shop Work	6

SENIOR YEAR.

First Semester—

Hydraulics	5
Transformers and Alternating Currents.....	3
Dynamos—Laboratory	3
Electrical Design and Shop Work.....	6
Photometry and Electric Lighting.....	5

Second Semester—

Power Transmission	5
Steam Engine	3
Electrical Design and Shop Work.....	6
Electricity in Mining—Lecture.....	1
Mining Law—Lecture	1
Thesis	12

DEPARTMENTS.

MATHEMATICS.—The study of mathematics extends through the first three years of both courses. For the year 1902-3 the Freshman class will take up the subject of algebra at quadratics, in Wentworth's Higher Algebra, completing the work during the first semester. For the following year the standard of admission has been advanced so that the study of this subject will begin with chapter 24.

SOLID GEOMETRY.—The first twelve weeks of the Freshman year will be devoted to this study. After 1902-3 the whole of geometry, plane and solid, will be required for admission.

PLANE TRIGONOMETRY.—The last six weeks of the first semester of the Freshman year will be given to this subject during the coming year, and in years to come this study will be taken up at the beginning of the year.

SPHERICAL TRIGONOMETRY.—The first four weeks of the second semester will be devoted to the study of this subject, but after the year 1902-3 it will be assigned to the last half of the first semester.

ANALYTICAL GEOMETRY.—This year the Freshman class will devote the last fourteen weeks of the second semester to this study, and the Sophomore class will give the whole of the first semester to the same study, after that the subject will be assigned to the second semester of the Freshman year.

DIFFERENTIAL AND INTEGRAL CALCULUS.—The instruction in these subjects will be given mainly by lectures with Taylor's, Byerly's and Price's treatises as works of reference.

As far as practicable the instruction in these various branches of mathematics will be given with especial reference to the applications of the methods and principles involved to the problems that will arise in the study of Engineering and Mechanics.



CHEMICAL LECTURE ROOM.

CHEMISTRY AND METALLURGY.

GENERAL CHEMISTRY.—General Chemistry extends through the first half of the Freshman year. It consists of experimental work by each student at his desk covering the subject of inorganic chemistry, including the metals. He is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions upon each other. This work is the foundation upon which his general knowledge of chemistry is based and he is required to keep accurate notes, recording the reactions and principles involved in each experiment. Recitations are held covering the theoretical part of the work gone over.

This laboratory work is supplemented by a course of one lecture a week extending through the year, the student being required to take such notes as will enable him to explain in the class room the principles involved and illustrated on the lecture table. The student will be required to read various standard works on general chemistry.

QUALITATIVE ANALYSIS.—The second half of the Freshman year in the laboratory is devoted to qualitative analysis. The student studies the general schemes of analysis by which the various metals are separated from each other; then the acid radicals are detected and separated. The course covers the separation of metals in solution, dry salts, alloys and minerals in the wet way. The student must become conversant with all reactions involved and the writing and balancing of chemical equations. The spectroscope is used in connection with qualitative work for the detection of the fixed alkalies and the alkaline earths.

This work is supplemented by lectures and recitations.

QUANTITATIVE ANALYSIS.—Quantitative Analysis extends through the whole of the Sophomore year. The work embraces

all the work as carried on in the laboratories of the smelters, mills and mining plants. The various products of the smelters, such as crude ores, calcines, slags, mattes, flue dust, etc., are analyzed completely. The student, after being taught the technical methods of analysis will be required to practice rapid methods and the performing of a large number of determinations in one afternoon as required in actual smelter and mill work.

The course covers thoroughly the whole subject of mineral analysis, including gravimetric, volumetric and colorimetric methods, the analysis and calorific power of coals, the analysis of gases of combustion and illuminating gas, the standardization of solutions in acidimetry and alkalimetry, the standardization of cyanide solutions and the determination of gold and silver in cyanide solutions, the specific gravity of solids and solutions by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation room and problems in chemistry solved. Various novel and special analyses are worked and illustrated at the lecture table. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed.

The chemical laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student will have at his desk, water, sink, gas, blast and exhaust; and the extent of the practical work will be limited only according to his abilities and industry.

METALLURGY.—The subject of Metallurgy begins with a thorough course in assaying during the latter part of the first semester of the Junior year. It includes fire assays of gold, silver and lead in crude ores and smelter products, such as slags, mattes, copper and lead bullion, etc.

The laboratory is fitted with the most modern apparatus. Gas muffle and melting furnaces will be used. The retorting of amalgam, melting and refining of gold and silver bullion, and sampling and assaying of pig copper and lead. Every convenience known at the present time will be at the command of the student and the most modern and reliable balances will be used in assay work.

A course will be given in the metallurgy and refining of copper and the recovery and purification of the bi-products of gold and silver from the copper bullion. Various excursions to the smelters and reduction plants of Butte and Anaconda will be undertaken as the special subjects come before the student, where are practically illustrated all the various methods of treatment. With these processes of treatment at our very doors, the opportunity of seeing them will be surpassed by no single locality in the world. The operations of treatment from high and low grade ores as taken from the mines, to the refined products, can each be followed accurately and by nearly all of the various known methods. No two smelters of Butte are identical in operation.

The metallurgy of lead will be thoroughly treated by recitations, lectures and visits to the lead smelters of Montana. Also the metallurgy of iron, nickel, cobalt, zinc, aluminum, etc., and wherever practicable, excursions will be undertaken to see practical workings of these processes.

The various methods for the most advantageous treatment and extraction of the precious and useful metals from their various ores will be demonstrated by the student and checks made upon his work by means of analyses and assays. The comparative merits of the cyanide, amalgamation, hyposulphite, chlorination and other methods of treatment upon a given ore will be compared and determined. Excursions will include the cyanide and other mill plants and notes and reports required of the student concerning the details of these various processes examined.

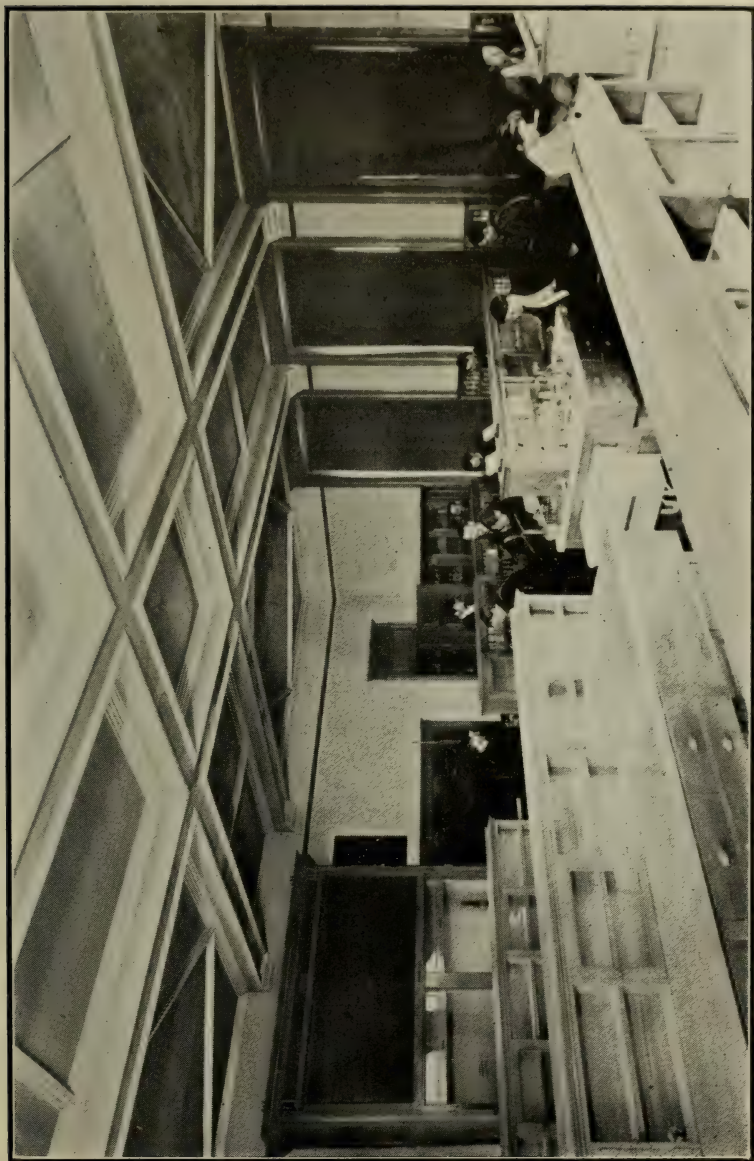
GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals.

Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster and fusibility, which will aid the student in the determination of minerals. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE ANALYSIS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and



LABORATORY FOR GEOLOGY AND MINERALOGY.

its accompanying apparatus and reagents. It includes, also, a discussion of isomorphism, dimorphism and the genesis of pseudomorphs. In the laboratory the student first studies the reaction of the elements by means of the use of known minerals, and then determines unknown minerals by a systematic study of their characters, both physical and chemical. Brush and Penfield's *Determinative Mineralogy and Blowpipe Analysis* is used in the laboratory. *Sophomore—First and Second Semester.*

DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This branch of geology treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarryman have to meet. *Scott's Introduction to Geology. Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's crust. *Scott's Introduction to Geology. Junior—First Semester.*

ECONOMIC GEOLOGY.—In this branch of study the uses and commercial value of rocks and ores are especially emphasized. The course includes a study of the common rock- and vein-forming minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution, special districts, and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, cements, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Junior—Second Semester.*

OPTICAL MINERALOGY.—This connecting link between Mineralogy and Petrography embraces a study of the principles of optics, including the propagation of light, total reflection, refraction, refractive indices, polarization, especially by means of the Nicol prism. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lenses, the camera lucida, and the preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form, crystalline texture, cleavages and parting, color in ordinary and in polarized light, relative refringence, optic axes, axes of elasticity, positive or negative, and uniaxial or biaxial character, relative birefringence, extinction in parallel polarized light, character of interference figures, and dispersion. *Senior—First Semester.*

PETROGRAPHY.—This subject is treated so as to include a study of the classification and determination of igneous, sedimentary and metamorphic rocks, chiefly by the aid of the microscope. It is closely dependent upon the precedent course. It is accompanied by a brief study of a summary classification,

and the methods used in determining rocks without the microscope. J. F. Kemp's Handbook of Rocks is used for the latter. *Senior—Second Semester.*

MICROCHEMICAL ANALYSIS.—The work in this subject is chiefly in the laboratory, and consists of a study of the methods of determination of the various elements and minerals by chemical reactions with minute quantities under the microscope. Behrens' Manual of Microchemical Analysis. *Senior—Second Semester.*

MECHANICS.

PHYSICS.—The subject of Physics is introduced in the Sophomore year. Throughout the course the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown, and finally enter the laboratory and make a series of physical measurements. While the whole subject of physics is covered, it is the aim to develop most thoroughly such parts as may add directly to the working knowledge of the mining engineer. The department is equipped with a fine assortment of modern apparatus both for the lecture demonstrations and for the individual work in the laboratory.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are also introduced. Aside from the nature and measurement of heat, its application to the steam-engine is considered, and a study is made of the properties of gases

and the transmission of energy by means of compressed air. The work in light includes a study of optical and engineering instruments and of the phenomena developed in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc.

During the second semester also the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light are determined and a familiarity is acquired with simple electrical measurements, the running and behavior of motors, the running and characteristics of dynamos, etc.

ANALYTICAL AND APPLIED MECHANICS.—A study of these subjects is commenced early in the course in connection with the drawing. Throughout the course the students are required to put into practice the principles and working knowledge acquired in the text-book study and in the lectures.

The work of the Sophomore year consists of a study of the mechanism of machinery, mechanical movements, modes of communicating motion, etc. In connection with this work, drawings of machine parts are made, attention being given to the proportioning of parts as determined by the best American practice.

During the Junior year a detailed study is made of Analytical and Applied Mechanics, particular attention is paid to such topics as are useful in the designing of machinery and structures connected with the hoisting and handling of ore and in the proportioning of materials in general in engineering structures. Many problems are solved during this course and applied in the drawing which follows throughout the year.

ELECTRICAL ENGINEERING.—The first two years of the electrical engineering course are identical with the first two years of the mining engineering course. During the Junior year the student pursues an extended course in the electrical laboratory. For this purpose an equipment has been provided consisting in part of galvanometers, resistance boxes, wheatstone bridges of various forms, condensers, induction coils, electro-dynamometers, ammeters, voltmeters, keys, switches, etc. A storage battery is furnished for use in this department. The student also makes a study of the telegraph and telephone systems and the elementary theory of the dynamo.

The electrotechnical work of the Senior year consists of designing, the theory of alternating currents, electric lighting and photometric work, power transmission and electrical testing in the dynamo laboratory.

The dynamo laboratory is equipped with a twelve-horse-power gas engine running a line shaft from which are belted direct and alternating current dynamos. Motors, transformers and the requisite measuring instruments are also provided. The shop is at present provided with a complete line of bench tools, a thirteen-inch lathe and emery wheels. Shafting and room are provided for extending the equipment of this department as soon as practicable.

The advantages of the electrical engineering department are offered to mining engineering students who wish to become proficient in this line of work in connection with the regular mining course, the work chosen being subject to the approval of the faculty.

MINING AND MINING ENGINEERING.

MINING AND MINING ENGINEERING.—The mining engineer in carrying out any mining enterprise may have use for any or all of the various branches of study taught in the course, these subjects are therefore developed with the special needs of the engineer in view. A special study, however, of the details involved in mining and the practical points developed by experience is of the highest importance. Instruction in this subject includes, therefore, the study of methods of mining, sinking of shafts, drifts, tunnels, adits, boring, breaking ground, blasting, timbering, drilling, etc. In the study of the machinery and methods of mining great advantage is derived by frequent visits to the mining plants in the immediate neighborhood. There are excellent opportunities for investigating hoisting machinery, the applications of electricity and water power, the use of compressed air, underground traffic, surface transportation, pumping, ventilation, illumination, etc.

SURVEYING.—Field practice in surveying occupies six weeks in both the first and third summer vacations, during which the student gives his whole time to the subject. There will be practice in the use and adjustment of instruments, land, mine and geological surveying, leveling and triangulation. The courses also include practical work in topographical drawing and map construction.

Preliminary to each of the above courses, the student spends a part of one semester in the study of the theory involved in the practice.

DRAWING.—During the first year the work in drawing consists in making elementary projections, working and isometric drawing of machinery, furnaces, structural work, tracing and



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blue printing. The drawing required during the remainder of the course is connected with allied subjects, as machine designs, mine surveying, etc. Topographical and geological maps will be constructed during the course.

GRAPHICAL STATICS.—The object of this course is to teach the theory of graphical analysis of stresses in structures. A considerable part of the time is spent in the drawing room solving problems, analyzing trusses, etc.

HYDRAULICS.—The course in hydraulics includes a study of problems connected with the storing and conveying of water, the structure of dams, water wheels, etc.

TESTING LABORATORY.—The work in the testing laboratory is designed to cover experimentally the formulas derived in the courses in mechanics as applied to various materials of construction. The elastic properties and strength of materials is also investigated.

POWER TRANSMISSION.—The transmission of power by means of compressed air, electricity, steam and other devices, including the machinery involved, is taken up in this course.

EXCURSIONS.

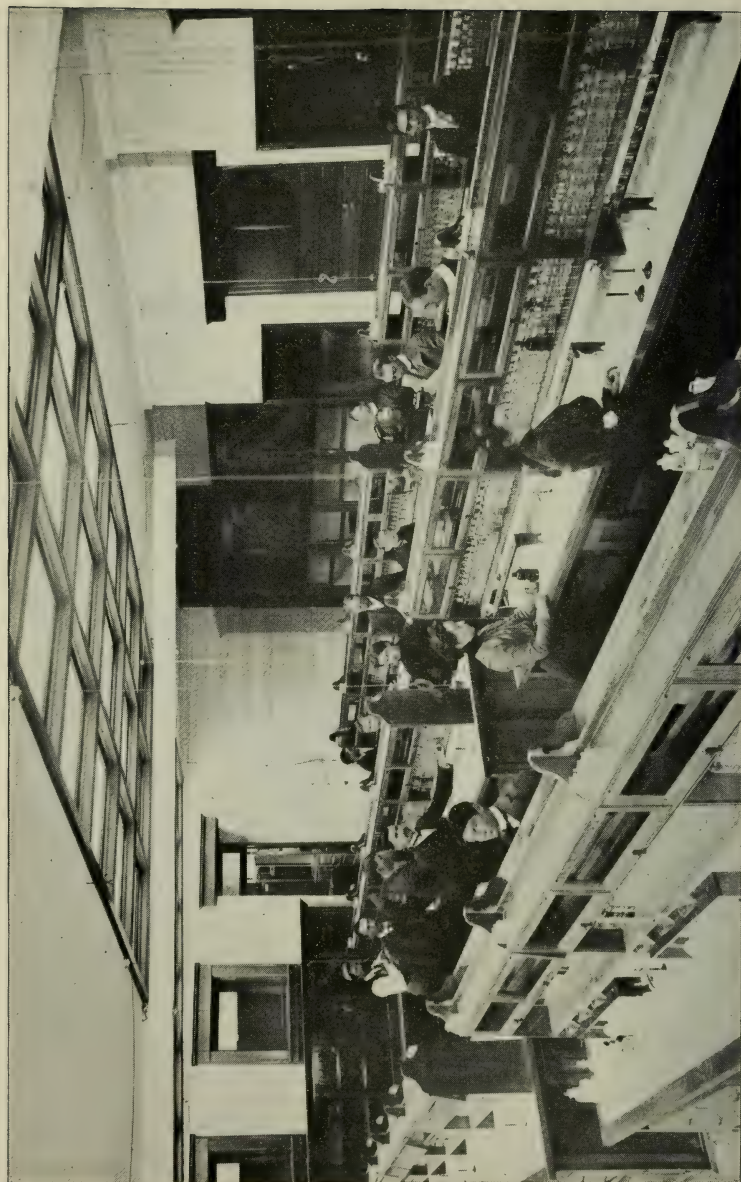
To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions will be made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter, the opportunity is here presented for daily observation of works whose development and whose product has given to the city of Butte the reputation of being the greatest mining center in the world. Reference is here made to the map and accompanying statistics that appear at the end of this Catalogue.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them, but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place a telephone message is sent to the school and the class and instructor can take the next street car to the plant and arrive in time to witness the event.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

Beside these comparatively short excursions, at the close of the Freshman and again at the close of the Junior year, six weeks of field practice in surveying and mining engineering are required. During these periods the entire time of the student is given to acquiring, under the direction of the professor in charge, a familiarity with the use and adjustment of engineering instruments and with the best methods of solving the problems that address themselves to the engineer.



CHEMICAL LABORATORY.

EQUIPMENT.

The equipment of the School of Mines has been secured through appropriations made by the legislature of the state. The total amount invested for this purpose now amounts to about \$30,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The lists that follow represent only a few of the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

CHEMICAL DEPARTMENT.—The Chemical Laboratory is equipped with the most modern style of student's desk. Each desk is provided with shelves for holding reagent bottles and glass cases to protect unfinished work from accident and dust. Drawers and cupboards are provided underneath the desk for holding apparatus not in use, having a single lock, without duplication, so that all the student's material is under his absolute control. There is also space for holding aprons, towels, etc. The tops of the desks are finished in glazed white tile and each individual desk has a sink, water and gas. On one side of the laboratory is a tile-topped table for blast-lamp and combustion work. The laboratory is provided with two commodious chemical hoods to carry away all noxious gases, the hoods also being supplied with hot plates, air-baths, steam evaporating pans and hydrogen sulphide apparatus. All ordinary chemicals for the use of the student are placed on side shelves. An electrolytic case is placed conveniently in the laboratory for the use of the student, the current of which is supplied from a storage battery. Bunsen filter and exhaust pumps, for rapid filtration, are placed at the convenience of the student.

The balance-room adjoins the chemical laboratory, being supplied with analytical and gold balances upon a table sup-

ported by piers constructed independent of the building, so that vibration is reduced to a minimum. In this room is also located a dark-room for spectroscopic work.

The chemical lecture room adjoins the general laboratory on the side opposite to that of the balance-room. It accommodates forty-eight students and this capacity can be increased if the occasion requires. The chairs are placed upon terraces and are provided with arms convenient for taking notes. A glass case on the side of the room holds the apparatus for lecture purposes. The demonstrating table is tile-topped and is provided with pneumatic trough, gas, blast, water, hydrogen, oxygen and an alternating and direct current of electricity up to 750 volts and 45 amperes. A hood backs the demonstrating table to carry off noxious fumes and is provided with a hot-plate, gas, blast and water for distilling purposes.

The private chemical laboratory is equipped with all modern conveniences for carrying on analytical work; having a chemical hood, working table, side tables, glass cases, shelves, electrolytic case, blast and combustion table with tile top, and the room is abundantly supplied with water, gas, blast, hydrogen, oxygen, electricity and conveniences for fractional distillation. In this room all chemical reagents are prepared for the use of the student; check analyses are made on his work; and all public analyses and assays are made by the instructor in charge. The adjoining room is the office containing the analytical and gold balances, protected from the fumes of the laboratory. A dark-room also adjoins for carrying on photographic work, spectroscopical analysis, making blue-prints, lantern slides, etc.

METALLURGICAL DEPARTMENT.—The Assay Laboratory is supplied with the most modern gas assay furnaces which, on account of their freedom from coal, ashes and soot, make them especially desirable for this work. Their ease of operation

gives the student a better chance to study the all-important effects of change of temperature, and the furnaces being completely under the control of the operator, when once he learns the proper heat necessary for carrying on a given operation, he can, at any time, secure that same temperature and sustain it absolutely for any length of time. For cupellation these furnaces are superior.

This laboratory also contains a gas melting furnace for melting and alloying metals, retorting amalgam and refining gold, silver and lead bullion. The pulp balances are also placed in this room, so that the student can weigh out his charges and watch his furnaces at the same time. The gold and silver balances being in the next room, are away from the influence of the heat of the furnaces.

The ore-dressing room has a laboratory crusher and a grinder capable of pulverizing ore to 80 mesh. The power for running these machines is furnished by a ten-horse power gas engine. There is also a buckboard and tables for rolling and sampling ores; sieves for grading ores from 10 mesh to 120 mesh; splitters, sampling pans and sampling apparatus. A high pressure blower is located in this room which furnishes an air blast for the gas furnaces, laboratories and lecture room.

The chemical and assay supply room is located next to the ore-dressing room and contains all the chemicals and apparatus necessary for carrying on the work of the laboratories. It is the intention of the school to have in stock a sufficient supply to last a year, and if at any time any articles are exhausted they are immediately replaced.

GEOLOGY AND MINERALOGY.—The Department of Geology and Mineralogy occupies three rooms on the second floor and two on the third floor. The lecture room, which is in the southeast corner of the building, has a seating capacity of about

seventy-five. The mineralogical laboratory is well lighted by windows on three sides; it occupies the southwest corner of the building, and is equipped for thirty-six students at one time. Each student has separate desk room, separate drawers, separate apparatus, reagents, etc. Gas is supplied to each student, and water pipes and sinks are conveniently placed about the room. For the general use of the class an analytical balance, a Jolly balance, a Westphal balance, a hood, and several series of minerals are provided. Thus, besides the large collection of minerals for ordinary blowpipe determinations, the department has a series of minerals classified according to the bases present, another series systematically arranged in the museum according to the chemical composition; and several other series are placed in the laboratory, convenient for reference or study at any time, which illustrate the various physical characters of minerals, such as hardness, specific gravity, structure, fusibility, color, luster, etc.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Penfield goniometers for personal use; the department has, further, three sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The office and supply room occupies the center of the south side of the building. The department is rapidly building up a good working library of books on mineralogy and geology, and it receives all the important American and foreign periodicals devoted to these sciences. Complete sets of some American journals especially devoted to economic and general geology have been obtained, as well as many valuable official geo-

logical reports. The students are invited and urged to become familiar with current scientific literature.

The elaborate mine models in the museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

Two series of fossils have been obtained, one representing all geological horizons, chiefly from classic European localities, and the other a series from the Tertiary basin of Paris, France. Additions from important American localities are being received.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are operated by means of an electric motor; each student is expected to learn to make his own thin sections of rocks. At the same time several series of thin sections already prepared, including the series with rock samples arranged to accompany Rosenbusch's classic text, are available for study. The latest model Nachet microscopes are employed for the microscopic studies of rocks and minerals. Three additional microscopes direct from this maker will be available for use during the school year 1902-3.

All the useful accessories for this work are at hand, including the Bertrand lens, the Fedorof inclining stage, the Michel

Levy comparateur, the Lacroix axial goniometer, and a micro-photographic apparatus. In order to permit ready and convenient use of the last a large dark room has been fitted up in the third story; it serves also for goniometric practice.

The Museum, which occupies a large room on the first floor, contains three mine models, a systematic collection of minerals, the Ward collection of rocks illustrating geologic phenomena, a series of fossils from the Tertiary of the basin of Paris, a specimen of copper glance from the Never Sweat mine, weighing nearly two tons, and a collection of ores of commercial importance.

PHYSICS.—The Department of Physics occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons and is provided with modern lecture-room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy table and apparatus for the measurement of physical constants. Among the measurements that may be made in the domain of mechanics and heat may be mentioned measurements of density, elasticity, the force of gravity, the latent heat of a fusion and of evaporation, specific heats, verification of Boyle's law, etc. For the measurements in electricity, galvanometers, resistance boxes with the necessary batteries, keys, etc., are provided.

For the work in light there is provided a spectrometer and an optical bank, together with lenses and attachments for the measurement of focal lengths and for constructing telescopes and microscopes.

ELECTRICAL APPARATUS.—In the basement of the building a dynamo room is provided with an eleven-horse-power gas en-

gine from which are belted direct and alternating current dynamos. A switch-board connects these machines with lines running to various parts of the building. A storage battery of ten cells is also connected to the switch-board. For the purpose of making measurements there is provided a collection of Weston volt and ammeters for both direct and alternating currents, rheostats, dynamometers, etc. The electrical laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements. In connection with this laboratory there is a small shop equipped with a thirteen-inch screw-cutting lathe and a set of hand tools for wood and metal working.

ENGINEERING.—The drafting rooms occupy two large and well lighted rooms on the second floor of the building. At present there are accommodations for seventy-two students in drawing.

The principal instruments for carrying on the work in surveying are: One complete mountain and mining transit, made by Buff & Buff; one complete engineer's transit with silver attachment, by C. L. Burger & Son; one complete engineer's transit, by Gurley; two levels and one sextant, by Gurley. Besides these instruments there is a collection of rods, poles, chains, tapes, etc., necessary in carrying on the work of the department.

NIGHT SCHOOL.

To meet what seemed to be a strong demand for a night school, it was determined to make an experiment in this direction. As in other mining centers, so here, there are many young men engaged in the various departments of the service

who are ambitious to enlarge their field of usefulness by fitting themselves for more advanced and responsible work than they are now doing.

The experiment was begun at the opening of the second semester of the year by offering courses of lectures in the several departments of the school, any one or more of these courses to be opened whenever a sufficient number of persons applied for that course. Pursuant to this plan, three courses were inaugurated, to-wit: one each in chemistry, mathematics and mineralogy. Two evenings per week were devoted to each subject and the student was held to the observance of the same rules as govern the regular day classes.

Thirty-two young men have been enrolled in the night school and their progress has been fairly satisfactory. It is perhaps too soon to say whether this experiment will justify the continuance of the night school next year. The instruction has been gratuitously given by the members of the faculty, but with the growth of the regular day classes their work has so increased that it will soon be impossible for them to take upon themselves the additional labor connected with the night school.

LECTURES ON MINING LAW.

The proper construction of the mining laws of the United States and of the several states is a subject of great importance, not only to the mining engineer, but to all who are interested in the ownership or management of mining property.

For this reason the Trustees of the School of Mines have inaugurated a course of lectures on this subject and secured as the lecturer Judge Clayberg, whose experience in connection with mining litigation, and as lecturer on this subject for Michigan State University, has specially fitted him for this work.

The first course of lectures was delivered in March and April of the present year. This course embraced a discussion of the methods by which a valid claim to a mining prospect may be initiated and the various steps by which claim may be ripened into a perfect title by means of a patent from the United States, and the rights obtained under this title. Under this latter head especial attention was given to the vexed question of "extralateral rights."

The course was very instructive and was attended, not only by the students of the school, but by a large representation from the bar of the city and citizens of Butte.

MAGAZINES.

The following scientific magazines will be found on the library tables and in the rooms of the members of the faculty, where they may be freely consulted by the students.

Electrical World and Engineer.	Zeitschrift f. Krystallographie.
Engineering News.	Zeitschrift f. praktische Geologie.
Engineering Magazine.	Petrographische und Mineralogische Mittheilungen.
Machinery.	Bulletin de la Societe Mineralogique.
Mathematical Magazine.	Bulletin Societe Geologique.
Annals of Mathematics.	Mines and Minerals.
Journal of the American Chemical Society.	Transactions of American Institute of Mining Engineers.
Berichte d. d. Chemische Gesellschaft.	Electrician.
Journal of the Chemical Society—London.	Chemical News.
Annales de Chimie et de Physique.	Engineering and Mining Journal.
School of Mines Quarterly.	Mining and Scientific Press.
Nature.	American Journal of Science.
Science.	Geological Magazine.
Journal of Geology.	Quarterly Journal of Geological Society.
American Geologist	Comptes Rendus.
Bulletin of the Geological Society of America.	Mineral Industry.
Neues Jahrbuch f. Geologie, Mineralogie, etc.	

The following newspapers are kindly furnished by their publishers free of charge:

Helena Herald (daily) Helena.	The Missoulian (daily) Missoula.
The Ravalli Democrat (weekly) Hamilton.	Blue Mountain American (weekly) Baker City, Oregon.
Great Falls Leader (daily) Great Falls.	The Tribune Review (weekly) Butte.

DONATIONS.

A complete record of all donations received by the School of Mines is kept at the institution in permanent form. The following is a summary list of gifts received from the establishment of the school to the first of May, 1902:

Official scientific reports have been received from:—

E. J. Babcock, State Geologist.....	Grand Forks, N. D.
E. H. Barbour, State Geologist.....	Lincoln, Neb.
R. A. Bell, Director Geological Survey.....	Ottawa, Canada
A. E. Birge, Director, Geological Survey.....	Madison, Wis.
W. S. Blatchley, State Geologist.....	Indianapolis, Ind.
John Byrne, Inspector of Mines.....	Helena, Mont.
Samuel Calvin, State Geologist.....	Iowa City, Ia.
W. B. Clark, State Geologist.....	Baltimore, Md.
A. S. Cooper, State Mineralogist.....	Sacramento, Cal.
C. H. Crantz, State Geologist.....	Springfield, Ill.
G. M. Dawson, Director, Geological Survey.....	Ottawa, Ont.
A. T. Dunn, Surveyor General.....	St. Johns, N. B.
J. A. Ferguson, Commissioner Agriculture, Labor and Industry.....	Helena, Mont.
Leo Gallaher, Acting State Geologist.....	Jefferson City, Mo.
T. W. Gibson, Acting Director Bureau of Mines.....	Toronto, Ont.
Edward Gilpin, Inspector of Mines.....	Halifax, N. S.
Erasmus Haworth, Geologist, University Geological Survey.....	Lawrence, Kas.
C. L. Herrick, President University New Mexico.....	Albuquerque, N. M.
H. P. Kummel, State Geologist.....	Trenton, N. J.
A. C. Lane, State Geologist.....	Lansing, Mich.
H. A. Lee, Commissioner of Mines.....	Denver, Col.
J. Obalski, Inspector of Mines.....	Quebec, Quebec
W. M. Robertson, Provincial Mineralogist.....	Vancouver, B. C.
James Russell, Commissioner of Mineral Statistics.....	Lansing, Mich.
Secretary of State.....	Austin, Texas
F. J. V. Skiff, Director, Field Columbian Museum.....	Chicago, Ill.
E. A. Smith, State Geologist.....	University, Ala.
J. C. Smock, State Geologist.....	Trenton, N. J.
W. C. Stubbs, Director Agricultural Experiment Station.....	Baton Rouge, La.
B. H. Tatem, Assayer, U. S. Assay Office.....	Helena, Mont.
J. E. Todd, State Geologist.....	Vermillion, S. D.
N. H. Winchell, State Geologist.....	Minneapolis, Minn.

Books, drawings, maps, etc., have been received from:

Allis-Chalmers Company, Machine Manufacturers.....	Milwaukee, Wis.
A. R. Campbell, Attorney.....	Butte, Mont.
C. W. Goodale, Supt. B. & M. Co.....	Butte, Mont.
U. S. Grant, Prof. Geology Northwestern University.....	Evanston, Ill.
Harper & Macdonald, Civil Engineers.....	Butte, Mont.
G. W. Irvin, Postmaster.....	Butte, Mont.
N. R. Leonard, President Montana School of Mines.....	Butte, Mont.
Henry R. Worthington, Pump Manufacturer.....	Brooklyn, N. Y.

Mineral and geological specimens have been received from:

Anaconda Copper Mining Company.....	Butte, Mont.
George F. Bartlett.....	Cumbermere, Canada
Boston & Montana Consolidated Copper and Silver Mining Com- pany.....	Butte, Mont.
C. T. Brown.....	Socorro, N. M.
Butte & Boston Copper Mining Company.....	Butte, Mont.
H. S. Clark.....	Butte, Mont.
R. M. Cobban.....	Missoula, Mont.
Colorado Fuel & Iron Company.....	Denver, Colo.
S. H. Crookes.....	Livingston, Mont.
Crystal Graphite Company.....	Dillon, Mont.
Walter Douglas.....	Bisbee, Ariz.
T. A. Dowdell.....	Encampment, Wyo.
B. H. Dunshee.....	Butte, Mont.
Elling State Bank.....	Virginia City, Mont.
John Gillie.....	Butte, Mont.
C. W. Goodale.....	Butte, Mont.
F. T. Green.....	Butte, Mont.
D. F. Hallahan.....	Republic, Wash.
A. Heffern.....	Sherman, Wyo.
Jas. H. Henley.....	Leadville, Colo.
J. W. Heywood.....	Salt Lake City, Utah
Victor G. Hills.....	Cripple Creek, Colo.
S. S. Hobson.....	Utica, Mont.
Homestake Mining Co.....	Lead, S. D.
Victor Houghman.....	Butte, Mont.
N. J. Isdell.....	Pony, Mont.
I. M. Jones.....	Butte, Mont.
J. E. Jopling.....	Ishpeming, Mich.
N. R. Leonard.....	Butte, Mont.
McCoy & Klein.....	Belgrade, Mont.
Montana Ore Purchasing Company.....	Butte, Mont.
Mount Morgan Gold Mining Co., Ltd.....	Mount Morgan, Australia
F. O. Nelson.....	Butte, Mont.
F. C. North.....	Polaris, Mont.

H. C. Packer.....	Hamilton, Mont.
A. P. Pohndorff.....	Butte, Mont.
Reynolds & McDowell.....	Butte, Mont.
Eugene Ring, Jr.....	Butte, Mont.
George H. Robinson.....	Butte, Mont.
R. H. Terhune.....	Salt Lake City, Utah
George W. Tower.....	Butte, Mont.
W. H. Weed.....	Butte, Mont.
C. E. White.....	Butte, Mont.
E. H. Wilson.....	Butte, Mont.
A. N. Winchell.....	Butte, Mont.
H. V. Winchell.....	Butte, Mont.
W. F. Word.....	Butte, Mont.

Models and machine parts have been received from:

John Ryerson.....	Chicago, Ill.
Henry R. Worthington.....	Brooklyn, N. Y.

The Niagara Mining Company has presented to the Museum of Geology and Mineralogy of the school the model of the Niagara and Black Rock mines, constructed by R. C. Brown, and used in the famous Black Rock-Niagara suit some years ago. This model has been held in trust for the School of Mines, since the settlement of the case, by C. H. Moore of Butte, Mont.

The Colusa Parrot Mining Company has presented to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the lawsuit with the Anaconda company, which was tried about a year ago. These models form an extremely valuable means of instruction, presenting, as they do, a graphic and easily understood picture of the workings and geological features of the mines in question.

The Anaconda Copper Mining Company has presented to the Department of Geology and Mineralogy a rock cutting machine and a rock grinding machine, both of large size and in first class condition. The gift includes, also, a complete set of accessories, such as Canada balsam, glass slides, cover glasses, several sizes of emery, etc.

Mr. C. W. Goodale of Great Falls, Montana, has presented

to the Museum his large collection of ores and minerals from various parts of the West and from Europe. This donation probably includes a thousand specimens, some of which it would be very difficult to replace; it furnishes a good beginning for the working collection of ores of the school.

The Anaconda Copper Mining Company has presented to the Museum a specimen of chalcocite ore from the thirteen hundred foot level of the Never Sweat mine which weighs approximately thirty-five hundred pounds. It is, without doubt, the largest specimen of its kind on exhibition in the world. It formed the chief feature of the exhibit of the company at the Omaha Exposition, whence it was brought and installed at the school wholly at the expense of the Anaconda company. This gift is accompanied by a series of samples illustrating the treatment of the ore at the concentrators and smelters of the company at Anaconda, Montana.

Mr. C. W. Clark of Butte, Montana, has loaned to the Museum a remarkably well chosen collection of crystallized gold specimens. This collection has not yet been placed in the Museum on account of the lack of a safe or vault in which it may be securely kept. It was exhibited at the Columbian Exposition at Chicago in 1893, where it was awarded a medal.

EXPENSES.

FEES.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.—To secure the state from loss for apparatus that may be broken by the student, a deposit will be required of each one, engaged in laboratory work, at the opening of the year. This deposit will be placed in the hands of the Treasurer of the Board of Trustees. Each student will be charged with the apparatus that may be issued to him. At the close of the year he will be credited with such articles as he returns in good order. The balance of this account will be returned to him.

The following is the list of deposits that will be required:

Mineralogy	\$10
Petrography and Microchemical Analysis.....	25
Freshman Chemistry	15
Quantitative Analysis	20
Assaying	25

If at any time before the close of the year the breakage amounts to the sum deposited, a new deposit will be required.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the city of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. Those who find it necessary to economize can avail themselves of opportunities for doing so similar to those they could find elsewhere.

GENERAL INFORMATION.

The city of Butte is universally known as the great mining center of the country, but the day has passed when it is only this and nothing more. Every year brings a large accession of population in which the best and most intelligent classes of the country are largely represented. Its public schools are in a flourishing condition, and nowhere is there a larger attendance in proportion to the population of a school age than here. The Butte which was known a few years ago as only a great mining camp, with a somewhat restless, roving population, living and doing business in rude or temporary quarters, has given place to the modern city, with spacious business blocks, halls, libraries, elegant churches, and many hundreds of residences such as would do credit to any city of its size anywhere. The moral and intellectual atmosphere of the place is such as to make it a desirable place for the location of a modern institution of learning.

The special advantages of the city as the home of a School of Mines grow out of the fact that here, as in no other place in the world, the mining student can obtain from actual observation a practical acquaintance with all the latest processes in mining and the reduction of ores. There is scarcely a process in any branch of mining or metallurgy known to the Northwest that may not here be seen in operation, or machinery of any recognized value that is not here employed.

The mining companies, their officers and employes, all feel a personal interest in the school, and every facility is freely offered for all proper exploration or examination of the mines and smelters that abound here and in this immediate vicinity. When it is known that the city of Butte furnished last year nearly one-fourth of the entire copper product of the world, beside many millions of dollars worth of silver, gold and lead,

the magnitude of its mining enterprises will be partially understood. There is every indication that its relative importance as a mining center will increase in coming years. The large area known to be rich mineral ground is growing larger, and its rich ledges of ore are each year being traced down to lower levels. The development already made has in large measure only scratched the surface of things, while the full revelation of its wealth of resources is reserved for generations yet to come.

The friends of the School of Mines are confident that with such an environment it will soon become one of the most important institutions of its kind in the country. The management of the school confidently invites the patronage of those who desire the education of a mining school either for themselves or their children.

MINING STATISTICS OF THE CITY OF BUTTE.

In support of the preceding statements the following synopsis of various official state and government reports and other information from authentic sources is here given.

BUTTE AS A COPPER PRODUCER.

	Pounds.
World's total production of copper for 1899 . . .	1,049,267,520
Butte's total production of copper for 1899	245,245,908
Total copper product of U. S. for 1899	568,666,921

This shows that nearly one-fourth of the world's output of the red metal for that year was secured from the mines of this city.

The yield of gold and silver is also productive of a large an-

nual revenue. The total value of Butte's output of gold, silver and copper for 1899 was \$54,907,883.82; of this total \$40,882,492.86 was derived from copper.

The population of the city and its suburbs is probably not more than 45,000; thus it appears that the value of the mineral product gives an average of more than \$1,200 for every man, woman and child living within its limits.

Not less than 6,000 of the adult male inhabitants of the city find their daily employment in the shafts, stopes and tunnels of the mines, far beneath the surface on which the city is built. Some one has said that Butte consists of two cities, one above and the other below the surface. The tallest building in the upper city is not more than 100 feet high; many of the workshops in the subterranean city are more than 2,000 feet from bottom to top, and the total length of their hallways, shafts and other passages aggregates the enormous sum of 500 miles. The total horsepower of the engines employed in the mines is about 25,000, and the daily output is 9,850 tons. This ore is treated at the smelters of this city and at the smelters of Anaconda and Great Falls. In the former city, which is only 27 miles from Butte, the smelting plant is of recent construction and is probably the largest in the world.

The subjoined map and description will show the location of the School of Mines with reference to the smelters and to some of the largest producing mines. A good street railway system renders all these points easy of access to the pupils of the school.

MINES AND SMELTERS OF BUTTE.

Their location with reference to the School of Mines and the depth of their shafts. (The figures refer to the map on the opposite page.)

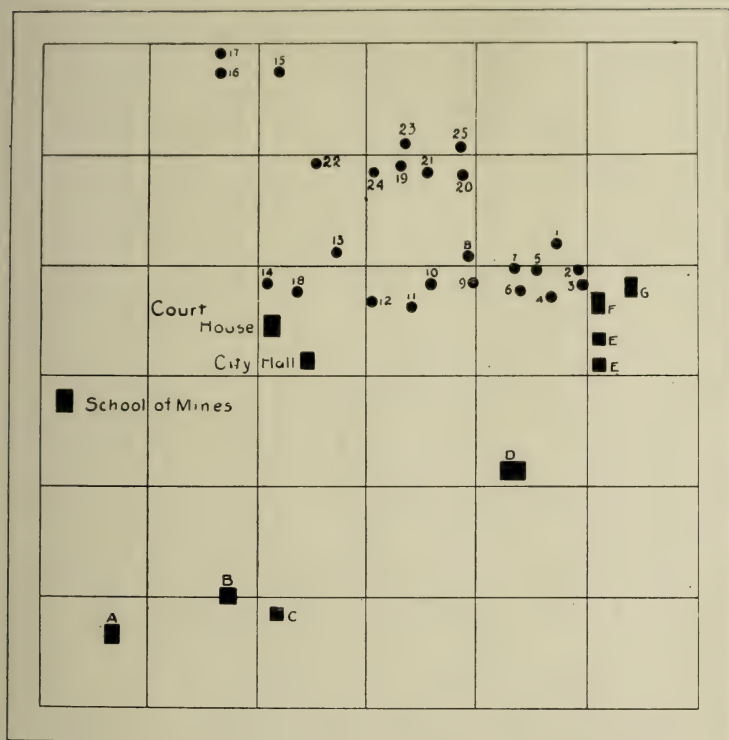
SMELTERS.

A—The Colorado Smelter.	E—Butte & Boston Smelters.
B—Butte Reduction Works.	F—M. O. P. Smelter.
C—Electric Plant.	G—Clark's Colusa Smelter.
D—Parrott Smelter.	

MINES.

The following is a list of some of the principal producing mines that are easily accessible to the school:

Map Number.	Name of Mine	Depth of Workings.
1.....	Minnie Healy	1,200 Feet
2.....	Tramway	800 Feet
3.....	Snohomish	800 Feet
4.....	Michael Devitt	800 Feet
5.....	Rarus	1,400 Feet
6.....	Pennsylvania	1,800 Feet
7.....	Johnstown	2,000 Feet
8.....	Mountain View	1,700 Feet
9.....	St. Lawrence	1,600 Feet
10.....	Anaconda	1,800 Feet
11.....	Never Sweat	2,000 Feet
12.....	Parrott	1,600 Feet
13.....	Nipper	1,200 Feet
14.....	Gagnon	1,800 Feet
15.....	Alice	1,000 Feet
16.....	Moulton	1,000 Feet
17.....	Lexington	1,400 Feet
18.....	Washoe	
19.....	Diamond	2,200 Feet
20.....	High Ore	2,200 Feet
21.....	Beil	1,650 Feet
22.....	Mountain Con.	2,000 Feet
23.....	Gray Rock	1,600 Feet
24.....	Green Mountain	2,200 Feet
25.....	Speculator	1,200 Feet



MAP OF BUTTE MINES.

CATALOGUE OF STUDENTS—1901-2.

JUNIOR CLASS.

Bender, Louis V.....Butte, Montana

SOPHOMORE CLASS.

Balmforth, Alfred J.....Butte, Montana
 Clark, Clara.....Butte, Montana
 Cosgrove, James P.....Butte, Montana
 Duling, J. Fred.....Stonewall, Colorado
 Foster, Rollins S.....White Sulphur Springs, Montana
 Harnan, Will L.....Butte, Montana
 Irelan, Arthur L.....Helena, Montana
 Kuphal, Henry E.....Butte, Montana
 Little, Isabel.....Baltimore, Maryland
 MacRae, Lachlin D.....Sula, Montana
 McGee, John.....Butte, Montana
 McGuane, Harry H.....Butte, Montana
 Pauly, Peter L.....Basin, Montana
 Tallant, Harry S.....Butte, Montana
 VanGundy, Jay.....Deer Lodge, Montana

FRESHMAN CLASS.

Archibald, George.....Butte, Montana
 Brinton, Owen F.....Butte, Montana
 Brooks, Clarence A.....Pomeroy, Ohio
 Corey, Clarence R.....Ansonia, Connecticut
 Duthie, John M. Jr.....El Paso, Texas
 Elford, Basil E.....Anaconda, Montana
 Farnham, Leroy S.....Butte, Montana
 Hammond, Nelson.....Butte, Montana

Hume, Harry G.....	Butte, Montana
Kane, Louis M.....	Butte, Montana
Kemper, Lucy J.....	Butte, Montana
Kirby, Kenneth P.....	Butte, Montana
Mackel, Louis C.....	Ada, Minnesota
Meiklejohn, Archibald.....	Butte, Montana
Murphy, Emmett.....	Butte, Montana
Pratt, Paul D.....	Libby, Montana
Rickards, Howard B.....	Butte, Montana
Rix, Leslie H.....	Butte, Montana
Schloesser, Alexander R.....	Chicago, Illinois
Stevenson, Leon Clark.....	Alamo, Oregon
Sulzer, Harry D.....	Butte, Montana
Warfield, Herschell J.....	Butte, Montana
Wilcox, Arthur L.....	Butte, Montana

PREPARATORY STUDENTS.

Bovett, Clifford Alfred.....	Butte, Montana
Davis, David A.....	Butte, Montana
Feeney, Charles W.....	Butte, Montana
Fitzgerald, Ed.....	Thompson, Montana
Hammer, Fred.....	Butte, Montana
James, Calvin.....	Butte, Montana
Larson, Hiram.....	Deer Lodge, Montana
Lees, Charles E.....	Butte, Montana
MacLane, James.....	Butte, Montana
Masterson, James T.....	Butte, Montana
McLaughlin, William D.....	Butte, Montana
Monroe, Roy P.....	Butte, Montana
Payne, Thomas H.....	Butte, Montana
Pierce, Howard W.....	Butte, Montana
Reardon, Daniel.....	Butte, Montana
Wilson, T. Burt.....	Butte, Montana

NIGHT CLASSES.

Bretherton, W. B.	Chemistry
Burnham, A. B.	Chemistry
Cooney, B. E.	Mineralogy
Engelbach, Carl	Chemistry, Mathematics
Fisher, W. H.	Chemistry
Gage, L. G.	Chemistry, Mineralogy
Gibbs, H. A.	Chemistry
Gillie, J. M.	Chemistry, Mineralogy
Hayes, Edward	Chemistry
Hesse, Clarence M.	Chemistry, Mineralogy
Hewitt, M. A.	Chemistry
Jeslyn, C. F.	Chemistry, Mathematics
Kirby, Edgar L.	Chemistry, Mineralogy
Logan, J. J.	Chemistry
Marsland, Frank	Chemistry
McDaniel, A. K.	Mineralogy
McLeod, Neil	Chemistry, Mathematics
McPherson, E. A.	Chemistry
Merwin, H. N.	Chemistry
Murdoch, C. R.	Chemistry, Mineralogy
Persons, James	Mathematics
Poindexter, Marvin	Mineralogy
Ronan, Gerald L.	Chemistry
Smallwood, H. S.	Chemistry, Mineralogy
Stevens, H. R.	Chemistry, Mineralogy
Tolman, J. D.	Mineralogy
Trask, E. C.	Chemistry, Mineralogy
Twomey, D. L.	Chemistry, Mathematics
Vail, R. R.	Chemistry
Vigeon, E. C.	Chemistry, Mineralogy
Walsh, Joseph P.	Mathematics
Williams, H. T.	Mineralogy

SPECIAL COURSES.

Bowden, Wm. H.....	Butte, Montana
Corry, John B.....	Butte, Montana
Kellett, Josie.....	Butte, Montana
Miles, J. S.....	Butte, Montana
Mullaney, Martin.....	Butte, Montana
Murdock, C. R.....	Contact, Montana
Schmidt, John S.....	Butte, Montana

SUMMARY.

Juniors	1
Sophomores	15
Freshmen	23
	39
Special Courses	7
Preparatory	16
	62
Night School	32
	94
Less (twice counted).....	1
Total	93

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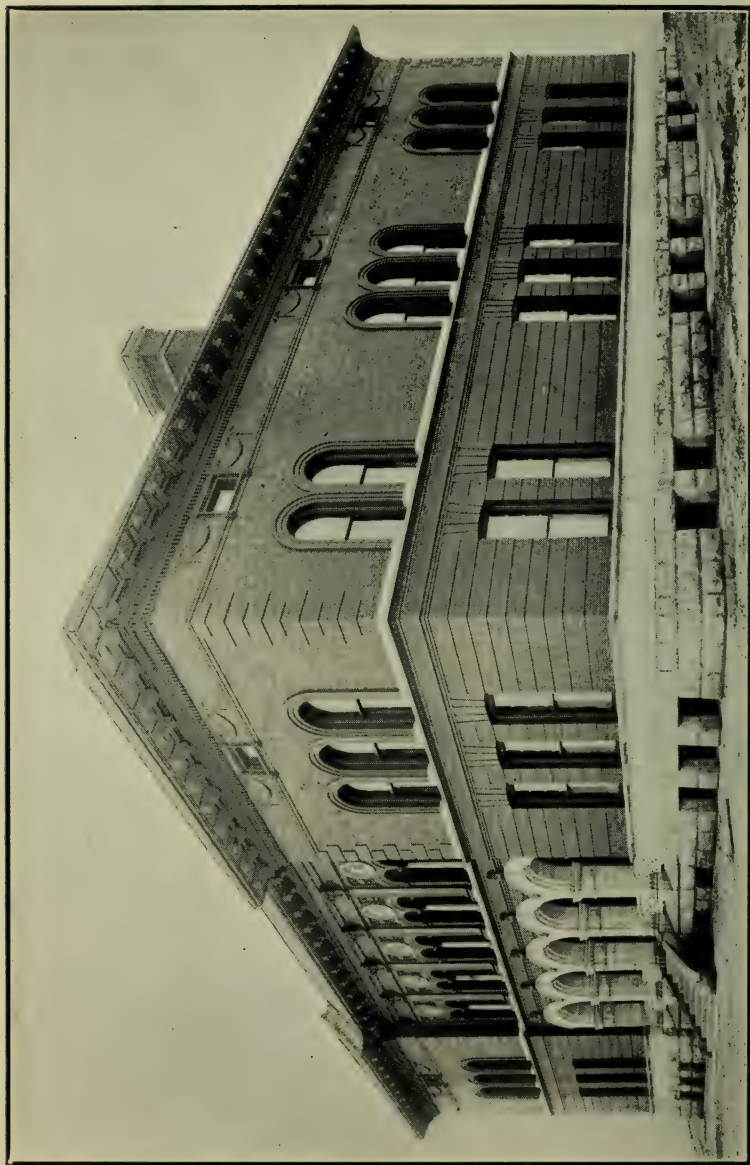
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BUTTE, MONTANA



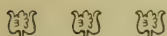
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Montana

State School of Mines

BUTTE



Third Annual Catalogue of
OFFICERS AND STUDENTS

For the Year 1902 - 1903

With Announcements for the Year
1903 - 1904



BUTTE, MONTANA



Calendar for 1903-4.

1903.

September 11 and 12—Entrance Examinations.

September 14—First Semester begins.

November 26—Thanksgiving—Holiday.

December 18—Holiday Recess to January 4, 1904.

1904.

January 28—Term Examinations begin.

January 29—End of First Semester.

February 1—Second Semester begins.

June 8—Term Examinations begin.

June 10—End of Second Semester.

June 14—Junior Field Work in Surveying begins.

July 26—Freshman Field Work in Surveying begins.

1904-5.

September 12—First Semester begins.

BOARDS OF CONTROL.

STATE BOARD OF EDUCATION.

(Ex-Officio.)

JOSEPH K. TOOLE, Governor.

JAMES DONOVAN, Attorney General.

W. W. WELCH, Supt. Public Instruction.

(Appointed.)

N. W. McCONNELL.....	Helena
(Term Expires February 1, 1907.)	
WM. M. JOHNSTON.....	Billings
(Term Expires February 1, 1907.)	
CHARLES R. LEONARD.....	Butte
(Term Expires February 1, 1906.)	
JOHN M. EVANS.....	Missoula
(Term Expires February 1, 1906.)	
G. T. PAUL.....	Dillon
(Term Expires February 1, 1905.)	
N. B. HOLTER.....	Helena
(Term Expires February 1, 1905.)	
J. G. McKAY.....	Missoula
(Term Expires February 1, 1904.)	
O. P. CHISHOLM.....	Bozeman
(Term Expires February 1, 1904.)	

OFFICERS OF THE BOARD.

JOSEPH K. TOOLE.....	President
JOHN M. EVANS.....	Vice-President
A. H. BARRETT.....	Treasurer
W. W. WELCH.....	Secretary
J. M. LEWIS.....	Clerk

COMMITTEE ON SCHOOL OF MINES.

W. M. JOHNSTON.	C. R. LEONARD.	G. T. PAUL.
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BOARD OF TRUSTEES.

JOHN E. RICKARDS.....	Butte
(Term Expires January 1, 1904.)	
GEORGE E. MOULTHROP.....	Butte
(Term Expires January 1, 1904.)	
WILLIAM A. CLARK, JR.....	Butte
(Term Expires January 1, 1904.)	
W. Y. PEMBERTON.....	Butte
(Term Expires January 1, 1906.)	
GEORGE H. ROBINSON.....	Butte
(Term Expires January 1, 1906.)	

OFFICERS OF THE BOARD.

J. E. RICKARDS.....	Chairman
GEORGE E. MOULTHROP.....	Secretary
W. A. CLARK, JR.....	Treasurer
J. A. POORE.....	Stenographer

OFFICERS OF THE SCHOOL OF MINES.

NATHAN R. LEONARD, A. M.,
President and Professor of Mathematics.

WILLIAM G. KING, A. M.,
Professor of Chemistry and Metallurgy.

ALEXANDER N. WINCHELL, Doctor Univ. Paris,
Professor of Geology and Mineralogy.

CHARLES H. BOWMAN, M. S.,
Professor of Mechanics.

E. H. MACDONALD, E. M.,
Professor of Mining Engineering.

JOHN B. CLAYBERG,
Lecturer on Mining Law.

CHARLES A. DIEHL, B. S.,
Assistant Professor of Chemistry.

LEON R. FOOTE, B. L.,
Instructor of the Preparatory Classes.

JOHN S. SCHMIDT,
Assistant in Chemical Laboratory.

JOSEPH ROBERT,
Janitor.

Montana State School of Mines.

HISTORICAL SKETCH.—The foundation for the Montana State School of Mines was laid in the "Enabling Act" in pursuance of which the States of North and South Dakota and the States of Montana and Washington were admitted into the Union.

This Act made an appropriation of forty thousand acres of public land to each of the Dakotas, and one hundred thousand acres to the State of Montana for the establishment and maintenance in each of a State School of Mines. This was the first step taken by our national government for the promotion of institutions devoted to the education of the youth of our country in the specialties that relate to the mining industry. It came as the natural sequence of the Morrill act of 1862, which provided for the establishment of state schools for instruction in agriculture and the mechanic arts. Every state in the Union has organized at least one school under the Morrill act, and the experience of a quarter of a century has shown substantial benefits accruing to the states and the country at large from the adoption of that policy.

The great development of the mining industry in the years immediately following the civil war, and especially the wonderful discoveries of the precious metals in the mountain states of the West gave to the calling of the miner an importance that attached to no other vocation save that of the farmer. It was easily seen that for the successful prosecution of his work the miner still more than the farmer was in need of a special education in the sciences that stand related to his vocation and to the occurrence of ores, and their extraction and proper treatment. . It required no profound investigations in political econo-

my to show that the prosperity of all our people was a result in which the prosperity of the miner was a most important factor.

It was on Washington's birthday in 1889 that this "Enabling Act" received the signature of the President of the United States. By this act our government became committed to the policy of promoting schools whose special purpose it should be to educate the rising generation in those branches that tend to fit them to be theoretical and practical miners.

In due time these three states availed themselves of the provisions of the act of 1889. The State of Montana promptly accepted the donation of lands for a School of Mines, and appointed officers to select the amount allowed by the government, and the legislature of the state determined to have the School of Mines established and put in operation as soon as the necessary preliminaries could be arranged. It chose the city of Butte, the great mining center of the state, as the location for the school and appointed a commission consisting of five persons to prepare plans and specifications for the erection of buildings for its accommodation, and to contract for and supervise their construction.

This commission was composed of Hons. F. E. Sargeant, John Gillie, W. W. Dixon, J. H. Leyson and Charles W. Goodale.

An interesting historical fact should be mentioned here in justice to the enterprise and public spirit of some influential citizens of the City of Butte. To enable the commission to carry out the work assigned to it, the legislature created a School of Mines fund, which was to consist of all monies received from the sale or leasing of the lands granted for the School. Against this fund the commission was authorized to draw warrants for their expenditures in erecting and equipping the building. When there were no monies in the fund to meet these warrants, it was originally provided that they should bear seven per cent interest from date of presentation until paid. In amending the law in 1897, the legislature inadvertently omitted the interest

clause. This was a very serious embarrassment to the commission and to the contractors. The latter could no longer discount these warrants to raise money to pay for labor and material. The building already erected was in condition to suffer great damage. Under the circumstances, Ex-Gov. J. E. Rickards made an earnest appeal to the business men of Butte to advance the money to take up these warrants and trust the State to reimburse them in due time. This appeal met with a generous response. Henry Mueller, Louisa H. Thornton, M. J. Connell, C. W. Clark, John Noyes and James H. Lynch advanced \$1,000 each; Messrs. Frank Klepetko, C. S. Batterman, The Case, Gravelle & Irvine Co., W. Connole, J. H. Curtis, John Forbis, Kemper Bros., W. R. Kernyon, J. W. Stewart, George C. Fitschen, Dan Tewey, H. L. Frank, Chris Nissler, I. Krueger, D. J. Hennessy, A. W. Price, J. K. Clark, Marchesseau & Valiton, Lynch Bros., and E. R. Fair, \$500 each. The Boston and Montana Mining Co. and the Butte and Boston Co. each advanced \$2,000.

This generous and timely aid enabled the Commission to carry forward the work and the State was thus saved from serious loss.

The plot of ground upon which the School of Mines building was erected is made up of portions of the Mint lode, donated for the purpose by Gen. Charles S. Warren; the Vanderbilt lode, donated by Messrs. George H. Casey, Levi J. Hamilton, R. H. Wearing, Joseph R. Silver and Robert A. Day; and of the Montrose Addition, donated by Henry Haupt and others. The dimensions of this plot are 376 feet in breadth by 500 feet in length. It is located near the western boundary of the city on the southern bench of "Big Butte." The situation commands a fine view of the city and surrounding country and with the early completion of the city railway will be easy of access to the mining, the business and the residence portions of the city.

The School of Mines building was erected in 1896-7. Its dimensions are 94 feet by 118. It is three stories high, with a spacious unfinished attic which is practically equivalent to another

story. The foundation story is of stone. Those above are of brick. It is nearly, but not absolutely fire-proof. The floors of the lower or basement story are of cement. The stairways are of stone resting on stone pillars and arches of brick. The halls are floored with tile laid in cement and metallic lath were used in plastering. The plan of the building was well conceived, and it is often spoken of as the most substantial public structure in the state. No part of the expense for the erection of this building was borne by the state. The legislature authorized the issue and sale of thirty-year bonds to the amount of \$120,000. These bonds bear interest at the rate of 5 per cent, and are redeemable after fifteen years. The state pledges the donated lands and all the income derived in any way therefrom to the redemption of these bonds, and further pledges itself to make good any deficiencies in the payment of interest, charging back, however, any sums that may be thus advanced to the landed endowment of the institution. The bonds were sold at par August 20, 1900. The monies that had been needed from time to time in the erection of the building were advanced by citizens of Silver Bow county, and these monies have now been refunded, or are being refunded from the proceeds of the bond sale.

ORGANIZATION OF THE SCHOOL.

The legislature at its Session in 1899 contemplated the opening of the school for the reception of pupils at some time in the year 1900, and made an appropriation of \$26,300 for the equipment of the building and for the maintenance of the school to the end of the fiscal year, November 30, 1900.

The trustees of the school at their meeting May 2, 1900, proceeded to elect a president, and instructed him to prepare and submit a plan of organization. His report, which was adopted, set forth:

1. That the aim and scope of the School of Mines was de-

terminated by sections 1570 and 1577 of the Political Code of Montana, and that the evident intention of the law was that this institution was designed solely for the purposes mentioned in those sections and not to duplicate unnecessarily any part of the educational work of other State Institutions.

2. That four professorships should be created, viz:

A Professorship of Mathematics, (To be in charge of the President.)

A Professorship of Chemistry and Metallurgy.

A Professorship of Mechanics and Mining Engineering.

A Professorship of Mineralogy, Geology and Mining, and to these should be added an Instructorship in Draughting.

3. That in view of the fact that in the course of a few years these professorships would have to be subdivided, the Board of Trustees in filling these chairs should take into consideration, primarily, the qualification of the applicants for these positions in respect to the first topic mentioned in the title of each professorship.

4. A general outline of a course of study and the subdivision of the work between the different Professors to be chosen.

The course of study outlined was to some extent modeled after that which for some years had been in successful operation at the Colorado School of Mines, and with this was combined some features of the course adopted at the Michigan School of Mines.

5. That the unsurpassed facilities offered by the City of Butte for the practical observation of various processes in Mining and Metallurgy should be duly considered and that the methods of instruction here to be employed should be such that special effort should be made to familiarize its students with the practical work in those lines.

It was noted that ever since the inauguration of Mining Schools, it has been asserted by the Superintendents and Managers of Mines that the graduates of these schools, though well

instructed in scientific and theoretical matters, were to a large extent unprepared to take responsible positions as mining engineers without a further and somewhat extended practical experience in the mines.

The American Institute of Mining Engineers, through the medium of papers, read and published by that body, have urged that the courses in these schools should be so arranged as to fit their graduates more fully for active duty as mining engineers.

It was felt that the Montana School of Mines should endeavor to meet this demand so far as the means at its disposal would permit.

The Board elected the following persons to the professorships named:

FACULTY OF THE MONTANA STATE SCHOOL OF MINES.

Nathan R. Leonard, A. M.—President and Professor of Mathematics.

William G. King, A. M.—Professor of Chemistry and Metallurgy.

Alexander N. Winchell, Doct. Univ. Paris.—Professor of Geology and Mineralogy.

Charles H. Bowman, M. S.—Professor of Mechanics and Mining Engineering.

Harold S. Boardman—Instructor in Draughting.

Subsequently Mr. Boardman declined the position offered him and the duties that would have devolved upon him were temporarily assigned to the Professor of Mechanics and Mining Engineering.

This organization has, since the opening of the school, been changed in three respects.

I. By the consent of the Board of Education, given at its meeting in December, 1900, a Preparatory Department, under

proper restrictions, has been established. This is not designed to do general elementary educational work, but only to give such specific preparation as is needed for admission to the Engineering course.

Professor Leon R. Foote was placed in charge of this Department and began his labors the first week in January, 1901.

2. A Professorship in Mining Engineering was created in 1901. Professor Albert B. Knight was chosen to fill this position and entered upon his labors in that department November 1, 1901. On May 1, 1902, in consequence of ill health he tendered his resignation as Professor, and Professor E. H. MacDonald, E. M., was chosen as his successor.

3. At the close of the year 1901-2, it was found necessary to add an Assistant Professor in the Department of Chemistry and Metallurgy and Mr. Charles A. Diehl, B. S. was elected to that position.

ATTENDANCE.

The School of Mines was opened for the reception of pupils September 11th, 1900. The total number admitted during that year was 39, classified as follows: Freshman 17, Sophomores 3, Junior 1, Special courses 10, Preparatory 8.

The second year began September 10th, 1901. The attendance this year was 62, to-wit: Preparatory 16, Freshman 23, Sophomores 15, Junior 1, Special courses 7.

A night school was opened for the spring semester commencing February 1, 1902. Three lines of study were provided for these courses, namely: Mathematics, Chemistry and Mineralogy. The numbers availing themselves of these courses were respectively, 6 in Mathematics, 25 in Chemistry, and 14 in Mineralogy.

At the opening of the third year on September 9th, 1902, the regular work of the institution had so increased that the

night school had to be discontinued. The attendance this year has been 70, to-wit: Preparatory 11, Freshmen 22, Sophomores 12, Juniors 12, Seniors 1, Special courses 12.

A comparative view of the attendance at a few of the leading Mining Schools of the country during the earlier years of their existence is here appended. It is taken from Vol. XXVII of the Transactions of the American Institute of Mining Engineers, pp. 718-21, and to that has been subjoined the attendance at the Montana School of Mines for the three years elapsed.

Comparative view of attendance at leading Mining Schools

INSTITUTIONS.	No. of Pupils for Five Successive Years..				
Colorado School of Mines for 1884-9 (organized in 1882).....	23	30	*	45	*
Michigan School of Mines for 1886-91 (organized in 1886).....	23	29	40	35	65
University of Minn. for 1891-6 (Mining Dept. organized in 1890).....	3	3	17	17	19
University of Cali. for 1884-9 (Mining Dept. organized in 1884).....	19	17	17	24	24
Columbia School of Mines for 1892-7 (organized in 1864).....	60	52	51	60	**47
Pennsylvania State College for 1893-7 (Dept. organized in 1893).....	9	22	23	23	*
Lehigh University for 1883-8 (Dept. of Mining started 1882).....	47	63	75	68	58
Montana State School of Mines* for 1900-3 (organized in 1900).....	39	62	70	..	..

*Attendance not given for this year.

**First five years could not be given.

The demand for a School of Mines in this, the "Treasure State," is very urgent, and as soon as our preparatory and high schools are well established and doing their appropriate work the number of pupils that will come hither from Montana alone will severely tax the resources and accommodations that this institution will have at its command.

FINANCIAL RESOURCES.

The financial resources of the School of Mines consist of the legislative appropriations which are made from time to time,



CLASS ROOMS SCHOOL OF MINES.

CHEMICAL LECTURE ROOM.

LECTURE ROOM FOR MECHANICS.

CHEMICAL LABORATORY.

SOPHOMORE DRAWING ROOM.

and the Congressional grant of 100,000 acres of land. The legislative appropriation for maintenance and improvements for the fiscal years, Nov. 30, 1902, to Nov. 30, 1904, amount to \$51,864.94.

At the close of the fiscal year, November 30, 1902, the Register of the Land Office reported that 99,581.10 acres of the land grant had been selected leaving 418.90 acres yet to be claimed. Only 455.81 acres of this land had been sold at that date, but 61,991.59 acres were under lease and the income therefrom is a little more than sufficient to pay the interest on the bonds that were sold to secure money to erect the School of Mines building. The income from this source for 1901 was \$6,222.23, and for 1902, \$7,105.32. As the interest on the bonds is only \$6,000.00 per year, the receipts above show that some surplus is accruing toward the final payment of the bonds.

CONDITIONS OF ADMISSION.

The School of Mines is open on equal conditions to all residents of Montana without regard to sex or race, and to the youth of other states and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be seventeen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra through the first twenty-three chapters in Wentworth's Higher Algebra (or an equivalent), plane, solid and spherical geometry, geography, elementary zoology or physiology, physical geography and English composition.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right, at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

Those who may be qualified for admission to some of the studies of the regular course, but are deficient in preparation for other studies, may be admitted and receive instruction under Mr. Foote in those branches in which their preparation is deficient.

Graduates from the accredited high schools of the state will be admitted without examination, on presentation of their diplomas.

LIST OF ACCREDITED HIGH SCHOOLS.

County High Schools:—

Beaverhead
Broadwater
Carbon
Custer
Fergus
Flathead
Gallatin
Jefferson
Park
Teton

City High Schools.--

Anaconda
Billings
Butte
Great Falls
Hamilton
Helena
Miles City
Missoula

COURSES OF STUDY AND DEGREES.

The course of instruction adopted for the School of Mines allows an election in the Junior and Senior years between certain studies, and for convenience these different lines of study are called, respectively, The Course in Mining Engineering and The Course in Electrical Engineering. Those who complete the first of these will be entitled to the degree of Engineer of Mines (E. M.); those completing the second, to the degree of Electrical Engineer (E. E.). These courses are here given in tabular form; the figures following each topic represent the number of hours per week given to class-room or laboratory work in that topic.

COURSE IN MINING ENGINEERING.

FRESHMAN YEAR.

First Semester—

Higher Algebra.....	5
Trigonometry, Plane and Spherical.....	4
General Chemistry	8
English	3
Mechanical Drawing	9

Second Semester—

Analytic Geometry.....	5
General Chemistry.....	10
English	3
Surveying	2
Drawing; Mechanical and Topographical.....	6
Surveying (Theory and Practice) six weeks.....	50

SOPHOMORE YEAR.

First Semester—

Differential Calculus.....	5
Physics	5
Chemistry; Qualitative Analysis.....	10
Crystallography and Physical Mineralogy.....	4
Blowpipe Methods	3
Drawing; Elementary Machine Design.....	3

Second Semester—

Integral Calculus.....	3
Physics	7
Elements of Mechanism.....	2
Chemistry; Qualitative Analysis.....	6
Descriptive Mineralogy.....	2
Determinative Mineralogy.....	6
Drawing; Machine Design.....	3

JUNIOR YEAR.

First Semester—

Analytic Mechanics.....	3
Chemistry; Quantitative Analysis.....	10
Geology; Physical and Historical.....	5
Metallurgy	3
Mining	2
Testing Laboratory	3
Drawing; Design and Construction.....	3

Second Semester—

Hydraulics	3
Mechanics of Materials.....	3
Mining	2
Mine Surveying (six weeks).....	4
Metallurgy	2
Quantitative Analysis and Assaying.....	9
Geology; Economic	3
Geological Excursions	3
Drawing; Design and Construction (twelve weeks).....	4
Mine Surveying and Mining (Practice) six weeks.....	50

SENIOR YEAR.

First Semester—

The Steam Engine.....	3
Graphical Statics	3
Mining	2
Ore Dressing	2
Metallurgy	3
Petrography or	
Electro-Metallurgy and Metallurgical Experimentation.....	10
Mining Engineering Design.....	6

Second Semester—

Mining Engineering.....	5
Ore Dressing Laboratory.....	3
Metallurgy	6
Metallurgical Design.....	8
Power Transmission	3
Mining Law	1

COURSE IN ELECTRICAL ENGINEERING.

(The Freshman and Sophomore years are the same as those of the Mining Engineering Course.)

JUNIOR YEAR.

First Semester—

Differential Equations	2
Dynamo Machinery	3
Electrical Laboratory, half semester.....	9
Machine Design and Drawing, half semester.....	4
Mechanics	3
Electrical Measurements	3
Testing Laboratory	3

Second Semester—

Hydraulics	3
Economic Geology	5
Dynamo Machinery	3
Electrical Design	3
Electrical Measurements—Lecture	1
Electrical Measurements—Laboratory	9
Shop Work	6

SENIOR YEAR.

First Semester—

Steam Engine	3
Transformers and Alternating Currents.....	5
Dynamos—Laboratory	3
Electrical Design and Shop Work.....	6
Photometry and Electric Lighting.....	3
Electro-Metallurgy	2
Statics	3

Second Semester—

Power Transmission	5
Steam Engine	3
Electrical Design and Shop Work.....	6
Electricity in Mining—Lecture.....	2
Mining Law—Lecture	1
Electrical Engineering	2
Polyphase-Current Machinery	3

PREPARATORY DEPARTMENT.

It has not been considered advisable to create a general preparatory department here, similar to those connected with other State schools of Montana. The State School of Mines is to be maintained as a technical school and its energies are to be confined within the sphere for which it was established. Preparatory education necessary for entrance to the schools of higher education is provided for in the accredited High Schools of the State. However this rule of the State Board of Education meets but a limited class, since the high schools are not numerous enough to prepare all who may desire to pursue courses in mining and metallurgy. For the benefit of those who have not the opportunity of a high school and for others who may be deficient in some subject necessary to pursue certain courses the State Board of Education has deemed it wise to establish a one-year preparatory course.

Because of the technical character of the courses of the School of Mines much stress is necessarily put upon a thorough preparation in mathematical and scientific subjects. The subjects taught are those found on the following program of studies. The methods of instruction are similar to those employed in the school and are as practical as the nature of the subject demands. The aim is to make the work in this department so nearly like that of the school that the student may be fully equipped in manner of study and methods of thought to do the work of the school successfully.

REQUIREMENTS FOR ADMISSION.

An applicant for admission to the preparatory department must be at least sixteen years of age, of sound bodily health and of good moral character.

He shall sustain a satisfactory examination in geography,

algebra to factoring, and arithmetic, including the metric system. (Satisfactory to mean a grade of 75 per cent.)

In lieu of an examination an applicant may present a teacher's county certificate of Montana of equal grade, provided the certificate is in force.

PROGRAM OF STUDIES.

First Semester—

Algebra	5
Geometry, Plane	5
Physiology	3
English	3

Second Semester—

Algebra	5
Geometry, Plane and Solid.....	5
Physical Geography	3
English	3

(The numbers refer to the hours per week given to recitation.)

COURSE OF STUDY.

ALGEBRA.—Beginning at factoring, the year's work will conclude with the 23d chapter of Wentworth's Higher Algebra.

GEOMETRY, PLANE AND SOLID.—Four books of Wentworth's Plane and Solid Geometry will be completed by the close of the first semester, and four more by the close of the second semester, three of which will be in solid geometry. The student will be required to demonstrate nearly all the exercises found at the end of the first and second books and to write out his demonstrations in exercise books. Numerous other exercises are given throughout the year to illustrate the propositions demonstrated.

ENGLISH.—The work in this branch will continue throughout the year and will include English grammar and composition. Much daily work in written composition will be required besides six compositions of 500 to 1,500 words each during the year.

PHYSIOLOGY.—One semester of three hours a week is given to this subject. Twelve will be given to the study of the human body, three weeks to biology, and three weeks to an introduction to paleontology.

PHYSICAL GEOGRAPHY.—Gilbert and Brigham's text is used, supplemented by readings from many authors upon the subjects, as well as upon particular parts of geography. Excursions will be taken to ascertain the difference in temperature and elevation between the bottom and the top of a mountain by means of thermometer and barometer, to observe the waste of land and other subjects suggested by the text. Observations will be taken and daily records kept of the temperature, of the direction of the winds, of the barometric pressure and of the kind of clouds.

The department has in its possession the following aids to the study of physical geography.

The Daily Weather Report.

131 U. S. Geologic and Topographic Maps of the U. S.

2 Folios of Physiographic Types.

Besides access to the publications of the United States Government since 1900, bearing upon physiographic subjects.

DETAILS OF COURSE OF INSTRUCTION.

MATHEMATICS.

FRESHMAN YEAR.

ALGEBRA.—Commencing with indeterminate equations in Wentworth's Higher Algebra, attention will be given to the theory and use of logarithms, to Series, to the Theory of Equations, and to the solution of numerical equations. Recitations daily through the term.

TRIGONOMETRY.—Plane and Spherical Trigonometry will also be taught during the first semester, illustrated by a large number of practical problems. Recitations four times per week.

ANALYTICAL GEOMETRY.—The point and straight line, in a plane. Different Systems of Coordinates. The Conic Sections. Discussion of General Equations of the second degree with two variables. Higher Plane curves. The point and straight line in space. Curved Surfaces and surfaces of revolution. Quantics. Daily recitations during the second semester.

SOPHOMORE YEAR.

DIFFERENTIAL CALCULUS.—Discussion of the method by limits and infinitesimals. Derivatives of functions. Successive differentiation. Maxima and Minima of functions. Curvature. Involution, evolutes and envelopes. Asymptotes. Singular points and tracing of curves.

Daily recitations or lectures during the first semester.

INTEGRAL CALCULUS.—General and definite integrals of differential functions. Rectification of curves and quadrature of surfaces. * Differential equations. Preparation of a table of

integrals of all ordinary forms. Three lectures and recitations per week through the second semester.

CHEMISTRY AND METALLURGY.

GENERAL CHEMISTRY.—General Chemistry extends through the Freshman year. It consists of experimental work by each student at his desk covering the subject of inorganic chemistry, including the metals. He is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions upon each other. This work is the foundation upon which his general knowledge of chemistry is based and he is required to keep accurate notes, recording the reactions and principles involved in each experiment. Recitations are held covering the theoretical part of the work gone over.

This laboratory work is supplemented by a course of one lecture a week extending through the year, the student being required to take such notes as will enable him to explain in the class room the principles involved and illustrated on the lecture table. The student will be required to read various standard works on general chemistry.

QUALITATIVE ANALYSIS.—The Sophomore year in the laboratory is devoted to qualitative analysis. The student studies the general schemes of analysis by which the various metals are separated from each other; then the acid radicals are detected and separated. The course covers the separation of metals in solution, dry salts, alloys and minerals in the wet way. The student must become conversant with all reactions involved and the writing and balancing of chemical equations. The spectro-scope is used in connection with qualitative work for the detection of the fixed alkalis and the alkaline earths.

This work is supplemented by lectures and recitations.

QUANTITATIVE ANALYSIS.—Quantitative Analysis extends through the whole of the Junior year. The work embraces all the work as carried on in the laboratories of the smelters, mills and mining plants. The various products of the smelters, such as crude ores, calcines, slags, mattes, flue dust, etc., are analyzed completely. The student, after being taught the technical methods of analysis will be required to practice rapid methods and the performing of a large number of determinations in one afternoon as required in actual smelter and mill work.

The course covers thoroughly the whole subject of mineral analysis, including gravimetric, volumetric and colormetric methods, the analysis and calorific power of coals, the analysis of gases of combustion and illuminating gas, the standardization of solutions in acidimetry and alkalimetry, the standardization of cyanide solutions and the determination of gold and silver in cyanide solutions, the specific gravity of solids and solutions by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation room and problems in chemistry solved. Various novel and special analyses are worked and illustrated at the lecture table. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed.

The chemical laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student will have at his desk, water, sink, gas, blast and exhaust; and the extent of the practical work will be limited only according to his abilities and industry.

METALLURGY.—The subject of Metallurgy begins with a thorough course in assaying during the latter part of the second semester of the Junior year. It includes fire assays of gold, silver and lead in crude ores and smelter products, such as slags, mattes, copper and lead bullion, etc.

The laboratory is fitted with the most modern apparatus.

Gas and coal muffle and melting furnaces will be used. The re-torting of amalgam, melting and refining of gold and silver bullion, and sampling and assaying of pig copper and lead. Every convenience known at the present time will be at the command of the student and the most modern and reliable balances will be used in assay work.

A course will be given in the metallurgy and refining of copper and the recovery and purification of the bi-products of gold and silver from the copper bullion. Various excursions to the smelters and reduction plants of Butte and Anaconda will be undertaken as the special subjects come before the student, where are practically illustrated all the various methods of treatment. With these processes of treatment at our very doors, the opportunity of seeing them will be surpassed by no single locality in the world. The operations of treatment from high and low grade ores as taken from the mines, to the refined products, can each be followed accurately and by nearly all of the various known methods. No two smelters of Butte are identical in operation.

The metallurgy of lead will be thoroughly treated by recitations, lectures and visits to the lead smelters of Montana. Also the metallurgy of iron, nickel, cobalt, zinc, aluminum, etc., and wherever practicable, excursions will be undertaken to see practical workings of these processes.

The various methods for the most advantageous treatment and extraction of the precious and useful metals from their various ores will be demonstrated by the student and checks made upon his work by means of analysis and assays. The comparative merits of the cyanide, amalgamation, hyposulphite, chlorination and other methods of treatment upon a given ore will be compared and determined. Excursions will include the cyanide and other mill plants and notes and reports required of the student concerning the details of these various processes examined.

GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations, receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals.

Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster and fusibility, which will aid the student in the determination of minerals. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE METHODS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and its accompanying apparatus and reagents. It includes, also, a discussion of isomorphism, dimorphism and the genesis of pseudomorphs. In the laboratory the student becomes familiar

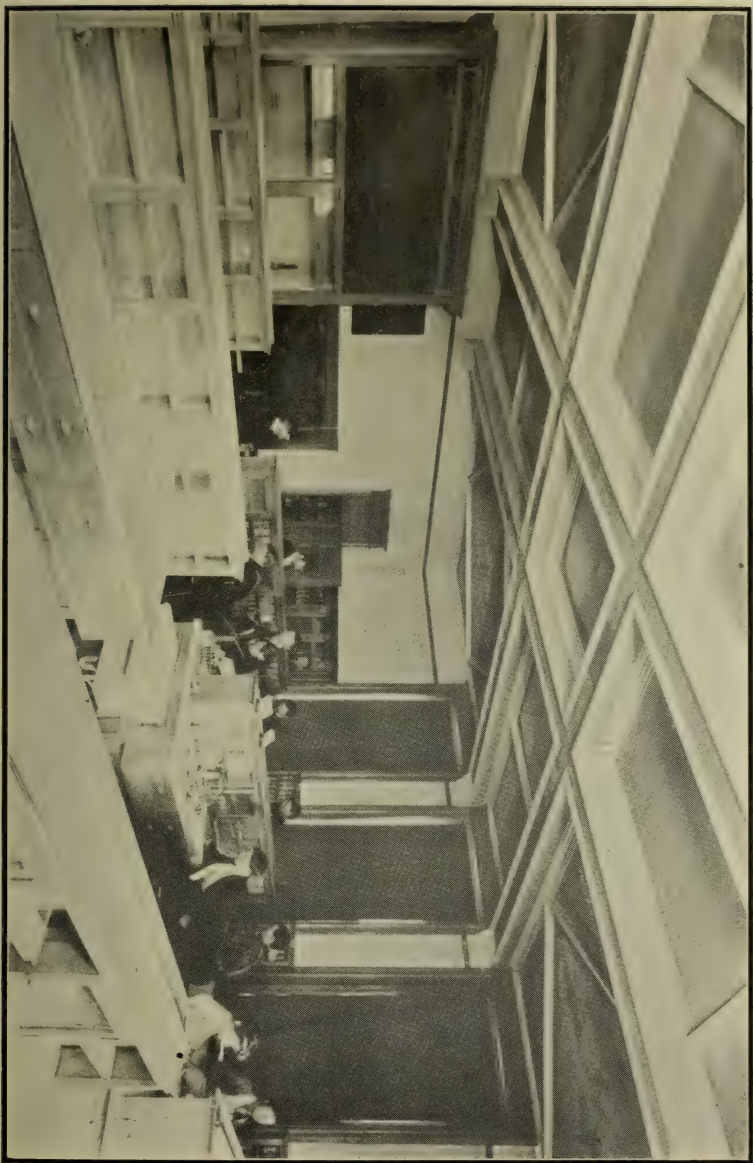
with the reactions of the important elements by means of the use of known minerals. Brush and Penfield's Determinative Mineralogy and Blowpipe Analysis is used in the laboratory. *Sophomore—First Semester.*

DETERMINATIVE MINERALOGY.—This course is wholly laboratory work. The student is given actual practice in the determination of minerals by their chemical and physical characters. He is expected to become thoroughly familiar with the common and important minerals so that he will recognize them at once. For the detailed study of Minerals, Brush and Penfield's laboratory text is used. *Sophomore—Second Semester.*

DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This branch of geology treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarryman have to meet. Scott's Introduction to Geology. *Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's



LABORATORY FOR MINERALOGY.

crust. Scott's Introduction to Geology. *Junior—First Semester.*

ECONOMIC GEOLOGY.—In this branch of study the uses and commercial value of rocks and ores are especially emphasized. The course includes a study of the common rock and vein-forming minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution, special districts, and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, cements, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Junior—Second Semester.*

PETROGRAPHY.—This course is introduced by a review of the principles of optics, including the propagation of light, total reflection, refraction, refractive indices, polarization, especially by means of the Nicol prism. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lenses, the camera lucida, and the preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form, crystalline texture, cleavages and parting, color in ordinary and in polarized light, relative refringence, optic axes, axes of elasticity, positive or negative, and uniaxial or biaxial character, relative birefringence, extinction in parallel polarized light, character of interference figures, and dispersion. When the student is able to recognize promptly the important rock-forming minerals he is able to take up the determination and classification of igneous, sedimentary, and metamorphic rocks, chiefly by the aid of the microscope. The course is accompanied by a brief study of the methods of determination of the various elements and minerals by chemical reactions with minute quantities under the microscope. *Senior—First Semester.*

MECHANICS.

PHYSICS.—The subject of Physics is introduced in the Sophomore year. Throughout the course the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown, and finally enter the laboratory and make a series of physical measurements. While the whole subject of physics is covered, it is the aim to develop most thoroughly such parts as may add directly to the working knowledge of the mining engineer. The department is equipped with a fine assortment of modern apparatus both for the lecture demonstrations and for the individual work in the laboratory.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are also introduced. Aside from the nature and measurement of heat, its application to the steam-engine is considered, and a study is made of the properties of gases and the transmission of energy by means of compressed air. The work in light includes a study of optical and engineering instruments and of the phenomena developed in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc.

During the second semester also the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light are determined and a familiarity is acquired with simple electrical measurements, the running and behavior of motors, the running and characteristics of dynamos, etc.

ANALYTICAL AND APPLIED MECHANICS.—A study of these subjects is commenced early in the course in connection with the drawing. Throughout the course the students are required to put into practice the principles and working knowledge acquired in the text-book study and in the lectures.

The work of the Sophomore year consists of a study of the mechanism of machinery, mechanical movements, modes of communicating, motion, etc. In connection with this work, drawings of machine parts are made, attention being given to the proportioning of parts as determined by the best American practice.

During the Junior year a detailed study is made of Analytical and Applied Mechanics, particular attention is paid to such topics as are useful in the designing of machinery and structures connected with the hoisting and handling of ore and in the proportioning of materials in general in engineering structures. Many problems are solved during this course and applied in the drawing which follows throughout the year.

GRAPHICAL STATICS.—This course includes instruction in the analysis of stresses in all common styles of roof and bridge trusses by graphic methods. Problems are solved involving every variation of load found in practice.

STEAM ENGINE.—The study of the steam engine is preceded by a short course in heat and thermodynamics. The mechanism of the various types of engines and their accessories are taken up, attention being paid to valves and valve gearing, governors, etc., also to the foundations, setting and management. The course includes a study of steam boilers of various types, their settings, accessories, care, management and inspection. Attention is paid also to the testing of the power plant for efficiency. The power plants in the immediate neighborhood offer special advantages for this study on account of the great variety of their applications.

POWER TRANSMISSION.—The transmission of power by means of compressed air, electricity, steam and other devices is taken up in this course. Special attention is given to the various systems of transmitting and utilizing electrical energy over long distances. A detailed study of the practical working and costs of such systems is made in connection with the large plants about Butte.

TESTING LABORATORY.—The work in the testing laboratory is designed to cover experimentally the formulas derived in the courses in mechanics. The elastic properties and strengths of building materials are investigated.

ELECTRICAL ENGINEERING.

The first two years of the electrical engineering course are identical with the first two years of the mining engineering course. During the Junior year the student pursues an extended course in the electrical laboratory. For this purpose an equipment has been provided consisting in part of galvanometers, resistance boxes, wheatstone bridges of various forms, condensers, induction coils, electro-dynamometers, ammeters, voltmeters, keys, switches, etc. A storage battery is furnished for use in this department. The student also makes a study of the telegraph and telephone systems and the elementary theory of the dynamo.

The electrotechnical work of the Senior year consists of designing, the theory of alternating currents, electric lighting and photometric work, power transmission and electrical testing in the dynamo laboratory.

The dynamo laboratory is equipped with a twelve-horse-power gas engine running a line shaft from which are belted direct and alternating current dynamos. Motors, transformers and the requisite measuring instruments are also provided. The

shop is at present provided with a complete line of bench tools, a thirteen-inch lathe and emery wheels. Shafting and room are provided for extending the equipment of this department as soon as practicable.

The advantages of the electrical engineering department are offered to mining engineering students who wish to become proficient in this line of work in connection with the regular mining course, the work chosen being subject to the approval of the faculty.

MINING AND MINING ENGINEERING.

Instruction in mining and mining engineering is given by lectures and recitations, by laboratory work, by excursions to mines within easy reach of the student and by practical work during the summer vacation.

An outline of the work is as follows:

ELEMENTS OF MINING.—Lessons are assigned on the geographical and geological distribution of the ores of the useful metals. The subjects of prospecting, locating and acquiring title to mining claims are next considered. Then follows a course of lectures designed to familiarize the student with the nomenclature of the subject and to outline to him the principal methods of exploitation. Two hours a week. *First Semester—Junior year.* Foster's Ore and Stone Mining.

MINING.—In this course lessons are assigned running parallel with the lectures. The work is illustrated by drawings, prints and models and by frequent visits to local mines where mining operations are observed.

The subjects covered include boring, breaking ground, supporting excavations, exploitation, winding, transportation, drainage, ventilation and illumination.

Two hours a week. *Second semester—Junior year and first semester of Senior year.* Foster's Ore and Stone Mining.

MINE SURVEYING AND MINING.—The work comprises a course of lectures on mine surveying with drawing room work in the solution of numerous problems, exercises in platting and a study of mine models, followed by practical work in the execution of mine surveys and study of mining operations. The school has not only models of different mines but, in one case, no less than four different models of the same mine; hence the comparative merits of model types can be studied to advantage.

Of the six weeks devoted to practical work, three are spent in making a survey and preparing the maps of some mine. The remaining three weeks are devoted to the study of coal and metal mining operations at the mines.

Four hours a week, six weeks, second semester—Junior year and fifty hours a week, six weeks, Junior vacation.

MINING ENGINEERING.—Instruction is given by lectures and recitations, study of professional papers, and excursions to mines in Butte and vicinity. The following is an outline of the course:

MINE PLANT.—The design and arrangement of plant including boiler plant, hoist head frame, underground and surface ore bins, compressor, trackage, means of lighting, ventilating, signalling, pumping, timber framing and repairing.

OPERATION.—Organization, management and accounting Leases, options, royalties. Examination and reports.

Five hours a week, first semester—Senior year.

ORE DRESSING.—Lectures, recitations and laboratory work on the art of Ore Dressing and ore dressing machinery.

Few, if any, localities afford better opportunities for the student to study the details of the dressing of sulphide ores. The

managers of local concentration plants have shown the greatest courtesy to the students of the School of Mines. It has been their custom to permit the students to visit their mills and engage in comparative trials of ore dressing machines under the conditions of actual practice.

The subject, in outline is as follows :

ORE DRESSING MACHINERY.—The construction and operation of the principal types of crushers, rolls, stamps, screens, classifiers, jigs, vanners and concentrating tables.

Principles of Ore Dressing, followed by a study of the design and operation of several mills.

Ore Dressing Laboratory. Laboratory work in concentration and practical work in stamp mills.

Two hours a week, first semester of Senior year and three hours a week, laboratory work, second semester of Senior year.

HYDRAULICS.—A knowledge of the subject of hydraulics is of paramount importance to the mining engineer, particularly to him whose field of labor is in the west. In the course as outlined below particular attention is devoted to the study of the subject as applied in the arts of mining and ore reduction. Opportunities for practical work and observation within easy reach of the student of the Montana State School of Mines are unexcelled.

1. Hydrostatics.
2. Theoretical Hydraulics ; a study of the laws of the flow of water through orifices, pipes, conduits and canals ; water power and water motors.
3. Measurement of water by weirs, (Field practice.)
4. Dams for water supply, mining and power purposes and for impounding tailings.
5. The design of ditches, flumes and launders for supplying ore reduction plants and for the conveyance of wood, ash, tailings and slags.

6. Domestic supply and sewerage for mining camps; pollution of streams by mining or metallurgical refuse.

7. Water rights; location and title under the laws of the State of Montana.

SURVEYING.—The course begins in the second semester of the Freshman year and is designed to give the student a thorough preparation for the field work at the end of the year. The class room work consists of lectures and recitations on:

1. Surveying instruments; their construction, adjustment, use and care.

2. Forms of field notes for different methods of surveying and levelling; office forms for computations.

3. Reducing and platting the notes in the drawing room (see topographical drawing); computation of areas.

Text-book; Johnson's Theory and Practice of Surveying.

Two hours per week second semester Freshman year.

SURVEYING.—(Theory and Practice.)—Practical work in the execution of surveys with lectures and recitations. One hour each day is spent in the recitation room, the remainder of the time in the field or in the drawing room. The student is required to execute the following surveys and prepare, where necessary, maps, profiles and complete reports.

1. Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain.

2. Adjustment of hand level, compass, wye level, transit and sextant.

3. Reading angles, horizontal and vertical.

4. Traverse survey with compass and chain.

5. Determination of meridian by solar observation and by observation on polaris.

6. Traverse survey with transit and steel tape, angles by repetition, azimuth and by deflections.

7. Official survey of mining claim in application for U. S.

patent; returns to consist of letters of transmittal, plat, field notes and computations; in form for transmission to U. S. Surveyor General.

8. Subdivision of a section of the public land according to Manual of Instructions to U. S. Deputy Surveyors.

9. Topographic survey with transit and steel tape.

10. Laying out a townsite, the plat to be prepared in shape for filing with Clerk and Recorder.

11. Levelling for profile and to fix grade, location of bench marks and contours.

12. Staking out excavation for foundation and determining volume of such excavation.

13. Staking out wagon road, irrigation ditch and flume line. Grades given or assumed, volumes to be determined from cross sections, costs to be estimated.

14. Determination of volume of a dam, a reservoir and an ore or waste dump by cross sections and approximately by contours with use of plainmeter.

15. Railroad Survey: A line about 5 miles long is located and cross sectioned.

Text-books: Johnson's Theory and Practice of Surveying. Searles' Field Engineering.

Fifty hours a week, six weeks, in the summer vacation Freshman year.

DRAWING AND DESIGNING.—The student's instruction in these subjects begins with the first semester of the Freshman year and, that he may acquire the skill necessary for his future practice as an engineer, he is required to devote a portion of his time, each week throughout his whole course, to work in the drawing room.

To those branches of the subject most important to the engineer the work of the student is confined, hence the major part of his work is in mechanical and topographical drawing and their practical applications.

When providing himself with drawing instruments the student should purchase only those of the highest grade. His work in drawing is expected to develop qualities of accuracy, neatness and speed; cheap or inferior instruments are a source of annoyance and loss of time to both student and instructor. The instruments required are:

- One 5½-inch compass.
- One 3¼-inch bow spacer.
- One 3¼-inch bow pencil.
- One 3¼-inch bow pen.
- One 5-inch ruling pen.
- One 6-inch metal protractor.
- One 8-inch 30-degree-60-degree amber triangle.
- One 8-inch 45-degree amber triangle.
- One K. & E. curve No. 1820-20.
- One K. & E. curve No 1820-1-6
- One triangular scale divided 12ths.
- One triangular scale divided 10ths.
- One dozen German silver thumb tacks, ⅜-inch diam.
- One T-square, 36-inch blade.
- One bottle waterproof black drawing ink.
- One bottle waterproof carmine drawing ink.
- Three 6-H drawing pencils.
- Two pencil erasers.
- One piece artist's gum.
- One Arkansas stone, small.
- One dozen Spencerian pens, No. 1, and holder.
- One bottle library paste with brush.
- One fine quality sponge, medium size.
- Three cabinet saucers 2½-inch diam.
- One half pan each moist colors:
 - Prussian Blue.
 - Carmine.
 - Gamboge.
 - Payne's Gray.
 - Burnt Sienna.
- Two sable brushes, small size.
- One board 24x32 inches, this should be made in Butte.

An outline of the work is as follows:

MECHANICAL DRAWING.—The use and care of drawing instruments and materials. The graphical solution of geometrical problems. Orthographic projections, the use of auxiliary planes. Sections, intersections and development. Isometric and oblique projection. Conventions for woods, metals and masonry. Lettering and tinting. Plans, elevations and sections.

Nine hours a week first semester and six hours a week first half of second semester—Freshman year.

Text-book: Thorne's Mechanical Drawing.

TOPOGRAPHICAL DRAWING.—This subject accompanies the class room work and field work in Surveying. The student is given the field notes of actual surveys, forms for the office work of reduction are provided, and he is required to reduce and plat the notes. The work comprises:

1. Making topographical signs, for the usual conventional surface representation and including additional conventions required by the mining engineer such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, etc. The methods of the U. S. Coast and U. S. Geological surveys are followed in this work.

2. Map Construction—Making scales, plotting by polar and rectangular co-ordinates, lettering, titles, borders, corners and north points.

Lectures and drawing room practice.

Six hours a week during the last half of the second semester, Freshman year.

MACHINE DESIGN.—The determination of the proper material and proper proportions of machine details. Screws, nuts and bolts; keys, cotters and gibs; rivets and riveted joints; shafts, shaft couplings and bearing; engine details; gearing; tracing and blue printing; filing and cataloguing shop drawings.

Recitations and drawing room practice.

Three hours a week during Junior year.

Text-book: Reid's Mechanical Drawing and Elementary Machine Design.

DESIGN AND CONSTRUCTION.—The design and construction of mining and ore reduction machines; cars, skips, cages, brakes, sheaves, drums, pipe lines, receivers, expansion joints, crushers,

rolls, screens, jigs and concentrating tables. The application of the student's knowledge of machine design to those machines and appliances forming a portion of the subject matter of the work in mining and ore dressing.

There are available for the student's use a large number of working drawings of various kinds of mining and ore dressing machines; opportunity is afforded by the local shops to observe the work of assembling the details of most machines above mentioned.

Lectures and drawing room practice.

Three hours a week, first semester and four hours a week, twelve weeks, second semester, Junior year.

MINING ENGINEERING DESIGN.—This course accompanies the work of the student in mining engineering. Beginning with lectures and drawing room practice in the design in wood, metal and masonry, of such structures as are within the ordinary wants of the mining engineer; the work leads up to the design and arrangement of plant for one or more of the operations of mining or ore dressing.

Lectures and drawing room practice.

Six hours a week, first semester of Senior year.

LECTURES ON MINING LAW.

The proper construction of the mining laws of the United States and of the several states is a subject of great importance, not only to the mining engineer, but to all who are interested in the ownership or management of mining property.

For this reason the Trustees of the School of Mines have inaugurated a course of lectures on this subject and secured as the lecturer Judge Clayberg, whose experience in connection with mining litigation, and as lecturer on this subject for Michigan State University, has specially fitted him for this work.

FRESHMAN ENGLISH.

The study of English is hereafter to be added to the work of the Freshman class. Rhetoric and English Literature will constitute the subjects studied, supplemented by much daily work in composition. Texts; the equivalent of Hill's Rhetoric and Painter's English Literature will be followed. Three recitations per week will be conducted throughout both semesters.

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions will be made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter, the opportunity is here presented for daily observation of works whose development and whose product have given to the city of Butte the reputation of being the greatest mining center in the world. Reference is here made to the statistics that appear at the end of this Catalogue.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them, but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place a telephone message is sent to the school and the class and instructor can take the next street car to the plant and arrive in time to witness the event.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

Besides these comparatively short excursions, at the close of the Freshman and again at the close of the Junior year, six weeks of field practice in surveying and mining engineering are required. During these periods the entire time of the student is given to acquiring, under the direction of the professor in charge, a familiarity with the use and adjustment of engineering instruments and with the best methods of solving the problems that address themselves to the engineer.

The following is a list of the excursions that have been conducted during the year 1902-3:

METALURGICAL EXCURSIONS.—Senior Class—To Murray, Utah; Dec. 29, 1902, visiting the works of The American Lead Smelting and Refining Co.

To Murray, Utah; Dec. 30, 1902, at Highland Boy Copper Smelter.

To Mercur, Utah; Jan. 1, 1903, at Cyanide Mill of Consolidated Mining and Milling Company.

Junior Class—To Anaconda, Mont.; Jan. 4-9, 1903, at Old and New Smelters.

To Butte, Mont.; Jan. 11-16, 1903, at Colorado Smelter, Butte Reduction Works, Butte & Boston Smelter and Montana Ore Purchasing Co. Smelter.

GEOLOGICAL EXCURSIONS. — Junior Class — Pennsylvania mine, Butte, Feb. 10, 1903.

To Ophir mine, South Butte, Feb. 17, 1903.

To Britannia mine, South Butte, March 3, 1903.

To Gagnon mine, Butte, March 10, 1903.

To West Stewart mine, Butte, March 17, 1903.

To exposures of glacial drift, hot spring deposits, rhyolite, etc., at Anaconda, Mont., March 24, 1903.

To exposures of quartz porphyry likes in vicinity of the Moonlight, Rarus and Modoc mines, March 31, 1903.

To Miocene lake bed east of Rocker, Mont., April 7, 1903.

To exposures of stratified volcanic tuff near Durant, Mont., April 14, 1903.

Making a geological sketch map of regions south of Big Butte, April 21 and 28.

MINING AND MINING ENGINEERING.—Senior Class.—November 20, 1902, to Butte Reduction Works; 8-hour trial New Century jig.

February 25, 1903, to Britannia mine; sketch of surface plant

March 4, 1903, to Travona mine; sketch of surface plant.

March 18, 1903, to Travona mine; sketch of surface plant.

March 27, 1903, to Ophir mine; underground workings.

April 4, 6, 8, 10 and 11, to Ophir mine; mine surveying.

April 15, 17, 18, 22 and 29, to Ophir mine; mine surveying.

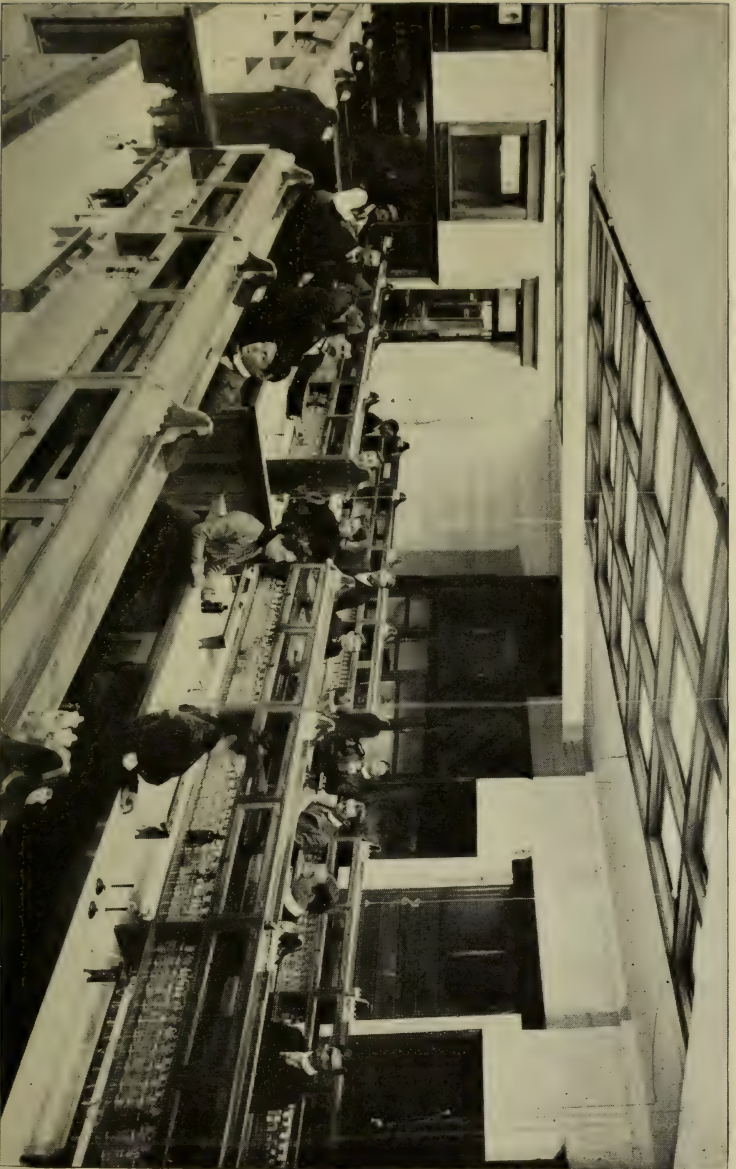
EQUIPMENT.

The equipment of the School of Mines has been secured through appropriations made by the legislature of the State. The total amount invested for this purpose now amounts to about \$30,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The lists that follow represent only a few of the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

MATHEMATICS.—The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of Engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

CHEMISTRY AND METALLURGY.—In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigation is very great and the successful prosecution of the purposes for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been devoted to the use of this department together with a lecture room on the second floor. In this space four laboratories have been fitted up, one each, for qualitative and quantitative analysis, one for assaying, and a professor's laboratory.

To these have been added a balance room, an ore dressing



CHEMICAL LABORATORY.

and sample room, a store room of laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast, Bunsen burners, a rack for chemical reagents and a cupboard with lock and key, so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The qualitative and quantitative laboratories are sufficient for the accommodation of 48 students, each. The Assay Laboratory is furnished with the best modern Gas Assay furnaces, which on account of their freedom from coal ashes and soot, are especially desirable when this work has to be conducted in the same building with other departments of the school. It is hoped that in the near future some arrangements may be made whereby this work can be conducted under a separate roof and by the use of coal, mainly, instead of gas. Such a change would enable the student in assaying to pursue the same course and under the same conditions that he will afterward employ and meet in practical life.

The professor's private laboratory and preparation room is equipped with the modern conveniences for carrying on analytical work. In this room all the chemical reagents are prepared for the use of the students in the other laboratories, and all check analyses on the students' work are made. A dark room is connected with this laboratory and is used for photographic work, spectrum analysis and the making of blue prints and lantern slides.

The ore-dressing and sample room is provided with a laboratory crusher and a grinder capable of pulverizing ores to the size known as "80 mesh." It is also provided with a "buck-board" and tables for rolling and sampling ores; sieves for grad-

ing pulverized ores from 10 mesh to 120 mesh; splitters, sampling pans, and other sampling apparatus.

A high pressure blower located here furnishes an air blast for use in the assay room, and in the other laboratories, the power for running the crusher, grinder and blower is furnished by a ten horse-power gas engine located in the Mechanical and Electrical laboratory.

The students' balance room is provided with six analytical balances and a gold balance for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls or floor or the building so that the vibration is reduced to a minimum.

The Chemical Lecture room located on the second floor is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

GEOLOGY AND MINERALOGY.—To this department has been assigned:—a large room on the first or main floor as a museum, three rooms on the second floor, viz: a lecture room, an office and supply room, and a mineralogical laboratory, and three rooms on the third or attic floor. These rooms are designated as the thin section lathe room, the dark room, and the storage room.

The museum is occupied by models of mining properties in Butte, a large geologically colored topographic model of the United States, and various collections of minerals, rocks, and fossils. There are six mine models, namely:

1. Black Rock—Niagara model, constructed by R. C. Brown for the Niagara Mining Company.

- 2, 3. Colusa Parrot—Never Sweat models, made for the

Colusa Parrot Mining Company, one model to show the workings and another to show the economic geology of the mines.

4, 5. Colusa Parrot—Never Sweat models, made for the Anaconda Copper Mining Company, (loaned to the school) one being a block model and the other a skeleton model to show the relative direction of the various veins.

6. Colusa Parrot—Never Sweat model, made for the Colusa Parrot Mining Company, showing all the workings to a true scale; to be exhibited at St. Louis in 1904. This model is accompanied by a map of workings in the Colusa Parrot district made for the Colusa Parrot Mining Co.

The museum is mainly occupied by choice collections of minerals and geological specimens. Amongst these may be enumerated:

- a. Two ton specimen of copper ore exhibited at Omaha in 1898 by the Anaconda Copper Mining Company.
- b. Systematic collection of minerals.
- c. Series of fossils representing all geologic horizons.
- d. Collection of rocks illustrating geological phenomena.
- e. Series of ores of economic importance.
- f. Series of fossils from the Tertiary basin of Paris.
- g. Collection of rocks illustrating all petrographic types.

(The last collections are installed in one oak wall case 25 feet long by 7 feet high by 2 feet wide and four plate glass center cases with oak bases, each 10 feet long by 3 1-2 feet high by 2 feet wide.)

- h. Series of 336 thin sections of rocks illustrating all petrographic types.
- k. Oriented thin sections of important rock forming minerals.
- l. Other thin sections of rocks and minerals, about 300 in number.

The lecture room on the second floor is seated for the ac-

commodation of forty students, is provided with large blackboards, and with geological diagrams and maps.

The office and supply room contains :

a. Library of geology and mineralogy, including complete sets of some important periodicals, all current magazines devoted to these sciences, both American and European, a large number of text books and monographs, and a goodly share of the official geological publications.

b. Collection of common rocks for class study.

c. Extensive collection of minerals, classified according to their chief base present, for class use.

d. Collection of ores of special districts.

e. Three series of crystal models.

f. Collection of minerals for blowpipe analysis.

g. Chemicals and blowpipe apparatus.

h. Hydraulic blast, hood, oven with automatic temperature regulator, combustion furnace, etc.

The mineralogical laboratory is furnished with :

*Six modern blowpipe laboratory tables each 11 feet long by 4 feet wide by 5 feet high, provided with water and gas. The table tops are of plate glass with aluminum rims—each table will accommodate six students at one time. :—

Complete apparatus for each student.

An analytical balance, two Jolly balances, three Plattner scales, hydraulic blast, hood, Westphal balance, application goniometers, etc.

A collection of minerals to illustrate all their physical characters.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Perfield goniometers for personal use; the department has, further, three sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For

the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The elaborate mine models in the museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are operated by means of an electric motor; each student is expected to learn to make his own thin sections of rocks. At the same time several series of thin sections already prepared, including the series with rock samples arranged to accompany Rosenbusch's classic text, are available for study. The latest model French microscopes are employed for the microscopic studies of rocks and minerals.

All the useful accessories for this work are at hand, including the Bertrand lens, the Fedorof inclining stage, the Michel Levy comparateur, the Lacroix axial goniometer, and a microphotographic apparatus. In order to permit ready and convenient use of the last a large dark room has been fitted up in the third story; it serves also for goniometric practice and photographic work.

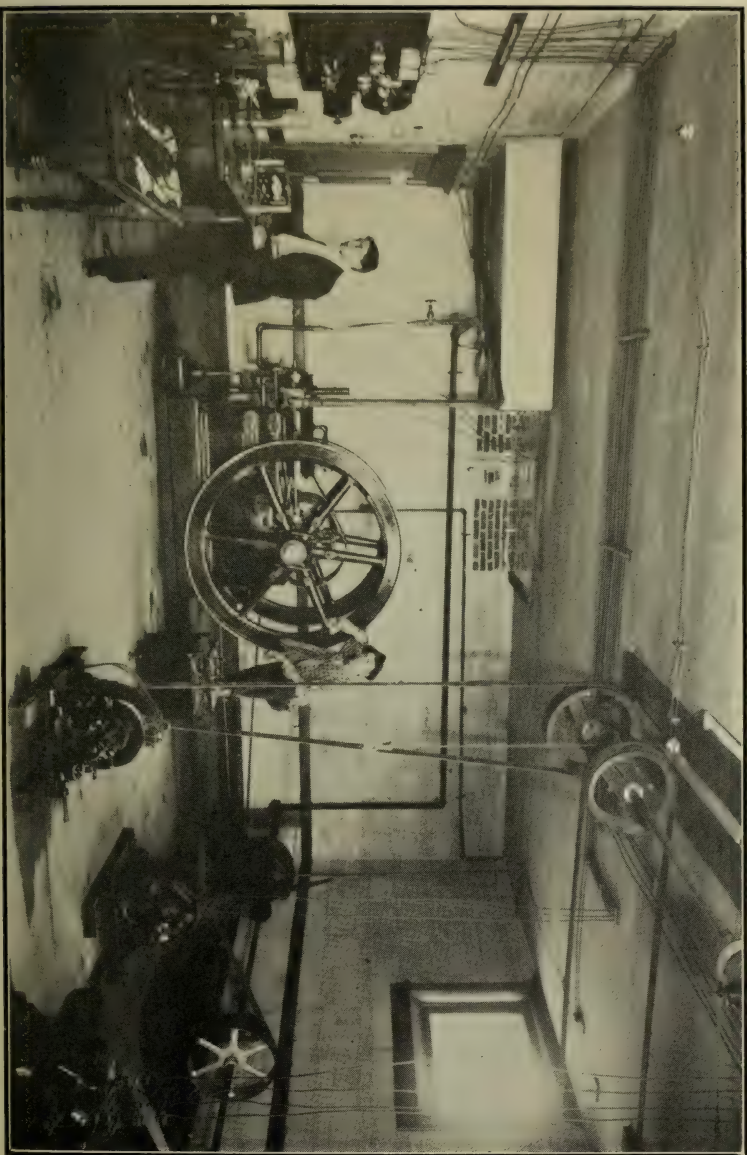
PHYSICS.—The Department of Physics occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons and is provided with modern lecture-room con-

veniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy table and apparatus for the measurement of physical constants. Among the measurements that may be made in the domain of mechanics and heat may be mentioned measurements of density, elasticity, the force of gravity, the latent heat of fusion and of evaporation, specific heats, verification of Boyle's law, etc. For the measurements in electricity, galvanometers, resistance boxes with the necessary batteries, keys, etc., are provided.

For the work in light there is provided a spectrometer and an optical bank, together with lenses and attachments for the measurement of focal lengths and for constructing telescopes and microscopes.

ELECTRICAL APPARATUS.—In the basement of the building a dynamo room is provided with an eleven horse-power gas engine from which are belted direct and alternating current dynamos. A switch-board connects these machines with lines running to various parts of the building. A storage battery of ten cells is also connected to the switch-board. For the purpose of making measurements there is provided a collection of Weston volt and ammeters for both direct and alternating currents, rheostats, dynamometers, etc. The electrical laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements. In connection with this laboratory there is a small shop equipped with a thirteen-inch screw-cutting lathe and a set of hand tools for wood and metal working.

TESTING LABORATORY.—The testing laboratory is equipped with a 100,000-pound Olsen machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Olsen compression micrometer especially designed



ENGINE AND ELECTRIC MOTOR ROOM.

for measuring the compression of stone cubes and other building materials; one Olsen improved deflection instrument for measuring the deflection of beams subjected to a load; one Henning's improved micrometer instrument for measuring the elongation or compression of long specimens. This instrument measures one ten-thousandth part of an inch and the point of contact of the screw is an electric contact through which signal is given.

MINING ENGINEERING.—The draughting rooms occupy two large and well lighted rooms on the second floor of the building. At present there are accommodations for seventy-two students in drawing.

The principal instruments for carrying on the work in surveying are: One complete mountain and mining transit, made by Buff & Buff; one complete engineer's transit with silver attachment, by C. L. Burger & Son; one complete engineer's transit, by Gurley; two levels, two Locke levels and one sextant, by Gurley. Besides these instruments there is a collection of rods, poles, chains, tapes, etc., necessary in carrying on the work of the department.

MAGAZINES.

The following scientific magazines will be found on the library tables and in the rooms of the members of the faculty, where they may be freely consulted by the students.

Electrical World and Engineer.
Engineering News.
Engineering Magazine.
Machinery.
Mathematical Magazine.
Annals of Mathematics.
Journal of the American Chemical Society.
Berichte d. d. Chemische Gesellschaft.
Journal of the Chemical Society—London.
Annales de Chimie et de Physique

Zeitschrift f. Krystallographie.
Zeitschrift f. praktische Geologie.
Petrographische und Mineralogische Mittheilungen.
Bulletin de la Societe Mineralogique de France.
Bulletin de la Societe Geologique de France.
Mines and Minerals.
Transactions of American Institute of Mining Engineers.
Electrician.
Chemical News.
Engineering and Mining Journal.

School of Mines Quarterly.

Nature.

Science.

Journal of Geology.

American Geologist.

Bulletin of the Geological Society
of America.

Neues Jahrbuch f. Geologie, Min-
eralogie, etc.

Mining and Scientific Press.

American Journal of Science.

Geological Magazine.

Quarterly Journal of Geological
Society of London.

Comptes Rendus.

Mineral Industry.

Mineralogical Magazine—London.

The following newspapers are kindly furnished by their publishers free of charge:

Helena Herald (daily) Helena.

The Ravalli Democrat (weekly)
Hamilton.

Great Falls Leader (daily) Great
Falls.

The Missoulian (daily) Missoula.

Blue Mountain American (week-
ly) Baker City, Oregon.

The Tribune Review (weekly)
Butte.

DONATIONS.

A complete record of all donations received by the School of Mines is kept at the institution in permanent form. The following is a summary list of gifts received from the establishment of the school to the first of May, 1903:

Official scientific reports have been received from:—

Wm. Anderson, Government Geologist.....	Natal, South Africa
E. J. Babcock, State Geologist.....	Grand Forks, N. D.
E. H. Barbour, State Geologist.....	Lincoln, Neb.
R. A. Bell, Director, Geological Survey.....	Ottawa, Canada
A. E. Birge, Director, Geological Survey.....	Madison, Wis.
W. S. Blatchley, State Geologist.....	Indianapolis, Ind.
H. Y. L. Brown, Government Geologist.....	Adelaide, South Australia
John Byrne, Inspector of Mines.....	Helena, Mont.
Samuel Calvin, State Geologist.....	Iowa City, Ia.
W. B. Clark, State Geologist.....	Baltimore, Md.
A. S. Cooper, State Mineralogist.....	Sacramento, Cal.
C. H. Crantz, State Geologist.....	Springfield, Ill.
G. M. Dawson, Director, Geological Survey.....	Ottawa, Ont.
A. T. Dunn, Surveyor General.....	St. Johns, N. B.
J. A. Ferguson, Commissioner, Agriculture, Labor and Industry.....	Helena, Mont.
Leo Gallaher, Acting State Geologist.....	Jefferson City, Mo.
T. W. Gibson, Acting Director, Bureau of Mines.....	Toronto, Ont.
Edward Gilpin, Inspector of Mines.....	Halifax, N. S.
Erasmus Haworth, Geologist, University Geological Survey.....	Lawrence, Kans.
C. L. Herrick, President, University of New Mexico.....	Albuquerque, N. M.
H. P. Kummel, State Geologist.....	Trenton, N. J.
Henry Landes, State Geologist.....	Seattle, Wash.
A. C. Lane, State Geologist.....	Lansing, Mich.
H. A. Lee, Commissioner of Mines.....	Denver, Colo.
A. Gibb Maitland, Government Geologist.....	Perth, West Australia
George P. Merrill, Curator, Dept. Geology, U. S. Nat. Museum.....	Washington, D. C.
A. Michel-Levy, Director, Geological Survey.....	Paris, France
J. Obalski, Inspector of Mines.....	Quebec, Canada
G. H. Perkins, State Geologist.....	Burlington, Vt.
W. M. Robertson, Provincial Mineralogist.....	Vancouver, B. C.
A. W. Rogers, Government Geologist.....	Cape Town, South Africa
David Ross, Secretary Illinois Bureau of Labor Statistics.....	Springfield, Ill.
James Russell, Commissioner of Mineral Statistics.....	Lansing, Mich.
Secretary of State.....	Austin, Tex.
J. J. Sederholm, Director Geological Survey of Finland.....	Helsingfors, Finland
H. J. H. Shott, Under Secretary for Mines.....	Wellington, New Zealand
F. J. V. Skiff, Director, Field Columbian Museum.....	Chicago, Ill.
E. A. Smith, State Geologist.....	University, Ala.
J. C. Smock, State Geologist.....	Trenton, N. J.

W. C. Stubbs, Director, Agricultural Experiment Station.....	Baton Rouge, La.
B. H. Tatem, Assayer, U. S. Assay Office.....	Helena, Mont.
J. J. H. Teall, Director, Geol. Survey United Kingdom.....	London, Eng.
J. Travis, Secretary for Mines.....	Melbourne, Victoria
J. E. Todd, State Geologist.....	Vermillion, South Dakota
C. D. Walcott, Director, U. S. Geol. Survey.....	Washington, D. C.
W. H. Wallace, Secretary for Mines.....	Hobart, Tasmania
F. A. Wilder, State Geologist.....	Grand Forks, North Dakota
N. H. Winchell, State Geologist.....	Minneapolis, Minn.

Books, drawings, maps, etc., have been received from:—

Allis-Chalmers Company, Machine Manufacturers.....	Milwaukee, Wis.
H. Foster Bain, Economic Geologist.....	Idaho Springs, Colo.
A. R. Campbell, Attorney.....	Butte, Mont.
C. W. Goodale, Supt. B. & M. Co.....	Butte, Mont.
U. S. Grant, Prof. Geology, Northwestern University.....	Evanston, Ill.
Harper & Macdonald, Civil Engineers.....	Butte, Mont.
J. H. Harper, Civil Engineer.....	Butte, Mont.
G. W. Irvin, Postmaster.....	Butte, Mont.
N. R. Leonard, President, Montana School of Mines.....	Butte, Mont.
H. V. Winchell, Economic Geologist.....	Butte, Mont.
Henry R. Worthington, Pump Manufacturer.....	Brooklyn, N. Y.

Mineral and geological specimens have been received from:

Anaconda Copper Mining Company.....	Butte, Mont.
George F. Bartlett.....	Cumbermere, Canada
Boston & Montana Consolidated Copper and Silver Mining Company	
.....	Butte, Mont.
C. T. Brown.....	Socorro, N. M.
Butte & Boston Copper Mining Company.....	Butte, Mont.
H. S. Clark.....	Butte, Mont.
R. M. Cobban.....	Missoula, Mont.
Colorado Fuel & Iron Company.....	Denver, Colo.
S. H. Crookes.....	Livingston, Mont.
Crystal Graphite Company.....	Dillon, Mont.
Walter Douglas.....	Bisbee, Ariz.
T. A. Dowdell.....	Encampment, Wyo.
B. H. Dunshee.....	Butte, Mont.
Elling State Bank.....	Virginia City, Mont.
O. L. Farnham.....	Butte, Mont.
John Gillie.....	Butte, Mont.
C. W. Goodale.....	Butte, Mont.
F. T. Green.....	Butte, Mont.
D. F. Hallahan.....	Republic, Wash.
A. Heffern.....	Sherman, Wyo.
James H. Henley.....	Leadville, Colo.
J. W. Heywood.....	Salt Lake City, Utah
Victor G. Hills.....	Cripple Creek, Colo.
S. S. Hobson.....	Utica, Mont.
Homestake Mining Company.....	Leeds, S. D.
Victor Houghman.....	Butte, Mont.
N. J. Isdell.....	Pony, Mont.
I. M. Jones.....	Butte, Mont.
J. E. Jopling.....	Ishpeming, Mich.

N. R. Leonard.....	Butte, Mont.
E. H. MacDonald.....	Butte, Mont.
Edward Massing.....	Holbert, Mont.
Paul McGeehan.....	Austin, Tex.
McCoy & Klein.....	Belgrade, Mont.
Montana Ore Purchasing Company.....	Butte, Mont.
Mount Morgan Gold Mining Co., Ltd.....	Mount Morgan, Australia
F. O. Nelson.....	Butte, Mont..
F. C. North.....	Polaris, Mont.
H. C. Packer.....	Hamilton, Mont.
A. P. Pohndorff.....	Butte, Mont.
Reynolds & McDowell.....	Butte, Mont.
Eugene Ring, Jr.....	Butte, Mont.
George H. Robinson.....	Butte, Mont.
Dr. A. C. Sandberg.....	Butte, Mont.
R. H. Terhune.....	Salt Lake City, Utah
James R. Thompson.....	Butte, Mont.
George W. Tower.....	Butte, Mont.
W. H. Weed.....	Butte, Mont.
C. E. White.....	Butte, Mont.
E. H. Wilson.....	Butte, Mont.
A. N. Winchell.....	Butte, Mont.
H. V. Winchell.....	Butte, Mont.
W. F. Word.....	Butte, Mont.

Models and machine parts have been received from :

John Ryerson.....	Chicago, Ill.
Henry R. Worthington.....	Brooklyn, N. Y.

The Anaconda Copper Mining Company has presented to the Department of Geology and Mineralogy a rock cutting machine and a rock grinding machine, both of large size and in first class condition. The gift includes, also, a complete set of accessories, such as Canada balsam, glass slides, cover glasses, several sizes of emery, etc.

Mr. C. W. Goodale of Butte, Montana, has presented to the Museum his large collection of ores and minerals from various parts of the West and from Europe. This donation probably includes a thousand specimens, some of which it would be very difficult to replace; it furnishes a good beginning for the working collection of ores of the school.

The Anaconda Copper Mining Company has presented to the Museum a specimen of chalcocite ore from the thirteen hundred foot level of the Never Sweat mine which weighs approximately thirty-five hundred pounds. It is, without doubt, the

largest specimen of its kind on exhibition in the world. It formed the chief feature of the exhibit of the company at the Omaha Exposition, whence it was brought and installed at the school wholly at the expense of the Anaconda company. This gift is accompanied by a series of samples illustrating the treatment of the ore at the concentrators and smelters of the company at Anaconda, Montana.

Mr. C. W. Clark of Butte, Montana, has presented to the Museum a remarkably well chosen collection of crystallized gold specimens. This collection has not yet been placed in the Museum on account of the lack of safe or vault in which it may be securely kept. It was exhibited at the Columbian Exposition at Chicago in 1893, where it was awarded a medal.

The Niagara Mining Company has presented to the Museum the model of the Niagara and Black Rock mines, constructed by R. C. Brown, and used in the famous Black Rock-Niagara suit some years ago. This model has been held in trust for the School of Mines, since the settlement of the case, by C. H. Moore of Butte, Montana.

The Colusa Parrot Mining Company has presented to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the lawsuit with the Anaconda Company. These are vertical and horizontal section models on glass plates.

The Anaconda Copper Mining Company has loaned to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the law suit with the Colusa Parrot Mining Company. One of these models is a block model in wood, and the other is a skeleton model, showing the veins and workings, also in wood.

These models form an extremely valuable means of instruction, presenting, as they do, a graphic and readily comprehended picture of the workings and geological features of the mines in question.

DONATIONS TO THE DEPARTMENT OF MINING ENGINEERING.

New York Safety Steam Power Co., 113 Liberty Street, N. Y.—Blue Prints of the Worthington Water Tube Boiler.

The Stirling Co., Pullman building, Chicago—Blue Prints and framed Photographs of the Stirling Safety Boiler.

Lead Lined Iron Pipe Co., Wakefield, Mass.—Samples of Lead Lined Pipe and Pipe Fittings.

Mr. F. A. Jones, Chief Engineer B. A. & P. Ry. Co., Anaconda, Mont.—Blue Prints and Bills of Material for the construction of Flumes, Tressles and Tunnel Linings.

Mr. S. P. Wright, Mechanical Engineer, Butte.—Numerous catalogues of general Mining Machinery and the use of an Engine Indicator and Test Gage for lecture purposes.

Mr. John S. Hickey, Superintendent A. C. M. Co., Foundry Dept., Anaconda, Mont.—Blue Prints of Gen. Mining Machinery.

Gates Iron Works—Gates Crusher, laboratory size.

Rand Drill Co.—One Kid Drill and Tripod.

Macomber & White—Samples of hoisting rope.

John A. Roeblings Sons Co.—Mounted samples of wire rope.

John B. Watson, Chief Engineer Tamarack and Osceola Mines, Calumet, Mich.—Samples of Tamarack mill products.

C. W. Goodale, Supt. Boston & Montana Mining Co.—Samples mill products.

D. W. Brunton, Consulting Engineer A. C. M. Co.—Prints of mine timbers.

EXPENSES.

FEES.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.—To secure the state from loss for apparatus that may be broken by the student, a deposit will be required of each one, engaged in laboratory work, at the opening of the year. This deposit will be placed in the hands of the Treasurer of the Board of Trustees. Each student will be charged with the apparatus that may be issued to him. At the close of the year he will be credited with such articles as he returns in good order. The balance of this account will be returned to him.

The following is the list of deposits that will be required:

FRESHMAN YEAR.

General Chemistry	\$10.00
Surveying	25.00

SOPHOMORE YEAR.

Qualitative Analysis	15.00
Mineralogy	10.00

JUNIOR YEAR.

Quantitative Analysis and Assaying.....	25.00
Mine Surveying	25.00

SENIOR YEAR.

Petrography	25.00
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If at any time before the close of the year the breakage amounts to the sum deposited, a new deposit will be required.

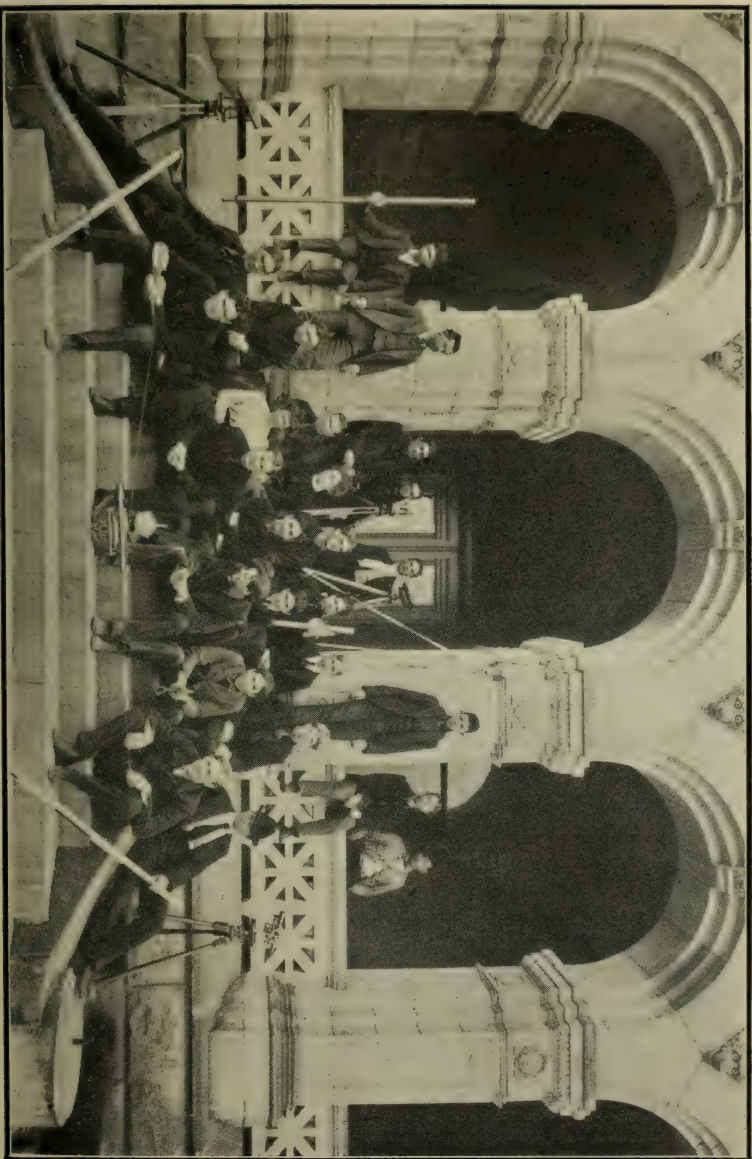
There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the city of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. Those who find it necessary to economize can avail themselves of opportunities for doing so similar to those they could find elsewhere.

GENERAL INFORMATION.

The city of Butte is universally known as the great mining center of the country, but the day has passed when it is only this and nothing more. Every year brings a large accession of population in which the best and most intelligent classes of the country are largely represented. Its public schools are in a flourishing condition, and nowhere is there a larger attendance in proportion to the population of a school age than here. The Butte which was known a few years ago as only a great mining camp, with a somewhat restless, roving population, living and doing business in rude or temporary quarters, has given place to the modern city, with spacious business blocks, halls, libraries, elegant churches, and many hundreds of residences such as would do credit to any city of its size anywhere. The moral and intellectual atmosphere of the place is such as to make it a desirable place for the location of a modern institution of learning.

The special advantages of the city as the home of a School of Mines grow out of the fact that here, as in no other place in the world, the mining student can obtain from actual observation a practical acquaintance with all the latest processes in mining and the reduction of ores.

The mining companies, their officers and employes, all feel a personal interest in the school, and every facility is freely offered for all proper exploration or examination of the mines and smelters that abound here and in this immediate vicinity. When it is known that the city of Butte furnished last year nearly one-fourth of the entire copper product of the world, besides many millions of dollars worth of silver, gold and lead, the magnitude of its mining enterprises will be partially understood. There is every indication that its relative importance as a mining center will increase in coming years. The large area known to be rich mineral ground is growing larger, and its rich ledges of ore are each year being traced down to lower



CLASS IN ENGINEERING—1902.

levels. The development already made has in large measure only scratched the surface of things, while the full revelation of its wealth of resources is reserved for generations yet to come.

The friends of the School of Mines are confident that with such an environment it will soon become one of the most important institutions of its kind in the country. The management of the school confidently invites the patronage of those who desire the education of a mining school either for themselves or their children.

MINING STATISTICS OF THE CITY OF BUTTE.

In support of the preceding statements the following synopsis of various official state and government reports and other information from authentic sources is here given.

BUTTE AS A COPPER PRODUCER.

	Pounds.
World's total production of copper for 1899.....	1,049,267,520
Butte's total production of copper for 1899.....	245,245,908
Total copper product of U. S. for 1899.....	568,666,921

This shows that nearly one-fourth of the world's output of the red metal for that year was secured from the mines of this city.

The yield of gold and silver is also productive of a large annual revenue. The total value of Butte's output of gold, silver and copper for 1899 was \$54,907,883.82; of this total \$40,882,492.86 was derived from copper.

The population of the city and its suburbs is probably not more than 45,000; thus it appears that the value of the mineral product gives an average of more than \$1,200 for every man, woman and child living within its limits.

Not less than 6,000 of the adult male inhabitants of the city find their daily employment in the shafts, stopes and tunnels of the mines, far beneath the surface on which the city is built.

Some one has said that Butte consists of two cities, one above and the other below the surface. The tallest building in the upper city is not more than 100 feet high; many of the workshops in the subterranean city are more than 2,000 feet from bottom to top, and the total length of their hallways, shafts and other passages aggregate the enormous sum of 500 miles. The total horsepower of the engines employed in the mines is about 25,000, and the daily output is 9,850 tons. This ore is treated at the smelters of this city and at the smelters of Anaconda and Great Falls. In the former city, which is only 27 miles from Butte, the smelting plant is of recent construction and is probably the largest in the world.

SMELTERS AND MINING PROPERTIES.

We give hérewith a partial list of the principal smelters and mining properties in the immediate vicinity of the school :

SMELTERS.

Butte Reduction Works.
Butte & Boston Smelters.
The Colorado Smelter.

The M. O. P. Smelter.
The Parrot Smelter.
Farrell Smelter.

MINING PLANTS.

Name of Mine.	Depth of Workings.
Anaconda	1,800 feet
Bell	1,600 feet
Bellona	600 feet
Berkeley	800 feet
Blue Jay	1,000 feet
Brittannia	400 feet
Buffalo	1,500 feet
Butte and Iowa.....	400 feet
Cambers.....	230 feet
Clear Grit	500 feet
Colusa Parrot	1,400 feet
Corra	1,200 feet
Diamond	2,200 feet
East Colusa	900 feet
East Gray Rock.....	1,600 feet
Ella	600 feet
Emma	800 feet
Gagnon	1,800 feet

Name of Mine.	Depth of Workings.
Mountain Con No. 1....	2,000 feet
Mountain Con No. 2....	1,500 feet
Mountain View	1,800 feet
Never Sweat	2,000 feet
Nipper	1,400 feet
Nora	400 feet
Old Glory	500 feet
Original	1,400 feet
Original No. 6.....	360 feet
Parnell	650 feet
Parrot	1,500 feet
Pennsylvania	1,400 feet
Plymouth	250 feet
Poulin	1,200 feet
Parnedell Parrot	200 feet
Rarus	1,600 feet
Rarus No. 1	200 feet
Ravin	400 feet

Gambetta	600 feet	St. Lawrence	1,800 feet
Gem	700 feet	Silver King	360 feet
Glengary	700 feet	Silver Bow No. 1.....	1,200 feet
Green Mountain	2,200 feet	Silver Bow No. 2.....	700 feet
Henry George	230 feet	Silver Bow No. 3.....	700 feet
High Ore	2,200 feet	Sinbad	800 feet
Iduna	300 feet	Sioux Chief	450 feet
Jessie	400 feet	Snohomish	350 feet
Leonard	1,200 feet	Speculator	1,400 feet
L. E. R.....	800 feet	Stella	800 feet
Little Mina	800 feet	Steward	1,250 feet
Michael Davitt	290 feet	Wake Up Jim.....	1,000 feet
Minnie Healy	1,100 feet	West Colusa	1,400 feet
Modoc	1,000 feet	West Gray Rock.....	700 feet
Moonlight	1,400 feet	West Steward	1,100 feet
Moose	400 feet		

Here in this partial list we have 67 mines whose total depth of working aggregates from 65,000 to 70,000 feet, and whose product in copper alone is nearly one-fourth of the copper product of the world. It is not merely true that these mines are in the near vicinity of the school—they are available to its students for all proper exploration and examination.

These mining properties are included within a space of about three miles square, within which the school is located, and the system of street railways is such that they are easily accessible to its pupils.

CATALOGUE OF STUDENTS—1902-3.

SENIOR CLASS.

Bender, Louis V.....Butte, Montana

JUNIOR CLASS.

Balmforth, Alfred J.....Butte, Montana
 Clark, Clara Butte, Montana
 Duling, J. Fred.....Stonewall, Colorado
 Irelan, Arthur L.....Helena, Montana
 Kuphal, Henry E.....Butte, Montana
 Little, Isabel Baltimore, Maryland
 MacRae, Lachlin D.....Sula, Montana
 McGee, John.....Butte, Montana
 Pauly, Peter L.....Basin, Montana
 Tallant, Harry S.....Butte, Montana
 VanGundy, Jay.....Deer Lodge, Montana

SOPHOMORE CLASS.

Archibald, George.....Butte, Montana
 Bowden, William H.....Butte, Montana
 Brinton, Owen F.....Butte, Montana
 Corey, Clarence R.....Ansonia, Connecticut
 Duthrie, John M., Jr.....El Paso, Texas
 Elford, Basil E.....Anaconda, Montana
 Farnham, Leroy S.....Butte, Montana
 Foster, Rollins S.....White Sulphur Springs, Montana
 Mackel, Louis C.....Ada, Minnesota
 McGuane, Harry H.....Butte, Montana
 Pratt, Paul D.....Libby, Montana
 Schloesser, Alexander R.....Chicago, Illinois
 Stevenson, Leon Clark.....Alamo, Oregon

FRESHMAN CLASS.

Dugan, John Francis.....	Butte, Montana
Feeney, Charles W.....	Butte, Montana
Gieser, Herbert S.....	Butte, Montana
Hammer, Fred L.....	Butte, Montana
Hammond, Nelson.....	Butte, Montana
Hume, Harry G.....	Butte, Montana
James, Calvin.....	Butte, Montana
Johns, John W.....	Butte, Montana
Kane, Louis M.....	Butte, Montana
Kemper, Lucy J.....	Butte, Montana
Kessler, Albert C.....	Helena, Montana
Larson, Hiram.....	Deer Lodge, Montana
Lees, Charles E.....	Butte, Montana
Meiklejohn, Archibald.....	Butte, Montana
Murphy, Emmett.....	Butte, Montana
Pierce, Howard W.....	Butte, Montana
Rickards, Howard B.....	Butte, Montana
Sultzor, Harry D.....	Butte, Montana
Warfield, Herschel J.....	Butte, Montana
Wilson, T. Burt.....	Butte, Montana
Young, Arthur B.....	Astoria, Oregon
Young, Siegfried A.....	Astoria, Oregon

PREPARATORY CLASS.

Baker, Jacob H.....	Butte, Montana
Bovett, Clifford Alfred.....	Butte, Montana
Clarke, Alfred.....	Melton, England
Davis, Henry Farmer.....	Oakwood, Missouri
McCrackin, Ralston H.....	Butte, Montana
McLaughlin, William D.....	Butte, Montana
McLean, J. W. H.....	Butte, Montana
Murdock, Samuel S.....	Rochester, Montana
Reardon, Daniel.....	Butte, Montana

Rice, J. Ransom.....	Butte, Montana
Rosche, Wilbert R.....	Denver, Colorado

SPECIAL COURSES.

Bradley, Thomas W.....	Butte, Montana
Brooks, Clarence A.....	Pomeroy, Ohio
Coates, Calvert.....	London, England
Cosby, Frederick Nugent.....	Butte, Montana
Creden, W. L. (M. E., Boston Inst. Tech.).....	Boston, Mass.
Donner, Jessie B.....	Butte, Montana
Fisher, W. H.....	Butte, Montana
Humphreys, H. J.....	Albany, Iowa
Kirby, Kenneth P.....	Butte, Montana
Orr, John T.....	Dillon, Montana
Roller, E. J.....	Butte, Montana
Savage, Charles D.....	Deer Lodge, Montana

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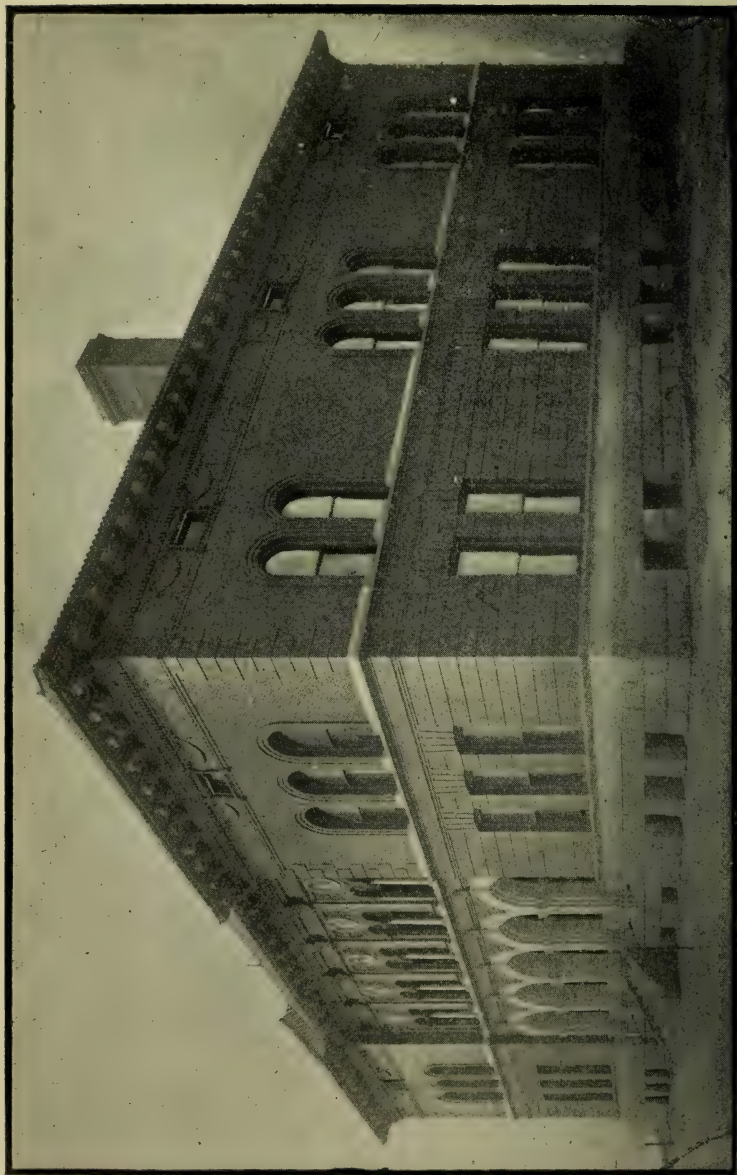
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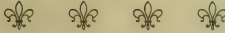
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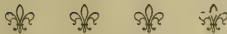
State School of Mines

Butte



FOURTH ANNUAL CATALOGUE OF
OFFICERS AND STUDENTS

FOR THE YEAR 1903 - 1904
WITH ANNOUNCEMENTS FOR THE YEAR
1904 - 1905



BUTTE, MONTANA

Calendar for 1904-5.

1904.

September 9 and 10—Entrance Examinations.
September 12—First Semester begins.
November 24—Thanksgiving—Holiday.
December 23—Holiday Recess to January 9, 1905.

1905.

January 26—Term Examinations begin.
January 27—End of First Semester.
January 30—Second Semester begins.
February 22—Washington's Birthday—Holiday.
June 6—Term Examinations begin.
June 9—End of Second Semester.
June 13—Junior Field Work in Surveying begins.
June 25—Freshman Field Work in Surveying begins.

1905-6.

September 11, 1905—First Semester begins.

CALENDAR FOR 1904-5.

JUNE							JULY							AUGUST							SEPTEMBER						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
5	6	7	8	9	10	11	3	4	5	6	7	8	9	2	1	2	3	4	5	6	4	5	6	7	8	9	10
12	13	14	15	16	17	18	10	11	12	13	14	15	16	13	11	12	13	14	15	16	14	15	16	17	18	19	20
19	20	21	22	23	24	25	17	18	19	20	21	22	23	20	21	22	23	24	25	26	21	22	23	24	25	26	27
26	27	28	29	30			24	25	26	27	28	29	30	28	29	30	31				25	26	27	28	29	30	

OCTOBER													NOVEMBER													DECEMBER													JANUARY 1905												
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S																	
2	3	4	5	6	7	8	1	6	7	8	9	10	11	12	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24																
9	10	11	12	13	14	15	13	14	15	16	17	18	19	20	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30																	
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23	24	25	26	27	28	29	25	26	27	28	29	30			25	26	27	28	29	30	31	29	30	31																											
30	31						27	28	29	30					25	26	27	28	29	30	31	29	30	31																											

FEBRUARY							MARCH							APRIL							MAY						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
			1	2	3	4				1	2	3	4	2	3	4	5	6	7	8	1	2	3	4	5	6	7
5	6	7	8	9	10	11	5	6	7	8	9	10	11	9	10	11	12	13	14	15	7	8	9	10	11	12	13
12	13	14	15	16	17	18	12	13	14	15	16	17	18	16	17	18	19	20	21	22	14	15	16	17	18	19	20
19	20	21	22	23	24	25	19	20	21	22	23	24	25	23	24	25	26	27	28	29	21	22	23	24	25	26	27
26	27	28					26	27	28	29	30	31		30							28	29	30	31			

JUNE							JULY							AUGUST							SEPTEMBER						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
4	5	6	7	8	9	10	2	3	4	5	6	7	8	6	7	8	9	10	11	12	3	4	5	6	7	8	9
11	12	13	14	15	16	17	9	10	11	12	13	14	15	13	14	15	16	17	18	19	10	11	12	13	14	15	16
18	19	20	21	22	23	24	16	17	18	19	20	21	22	20	21	22	23	24	25	26	17	18	19	20	21	22	23
25	26	27	28	29	30		23	24	25	26	27	28	29	27	28	29	30	31			24	25	26	27	28	29	30

BOARDS OF CONTROL.

STATE BOARD OF EDUCATION.

(Ex-Officio.)

JOSEPH K. TOOLE, Governor.

JAMES DONOVAN, Attorney General.

W. W. WELCH, Supt. Public Instruction.

(Appointed.)

N. W. McCONNELL.....	Helena
(Term Expires February 1, 1907.)	
WM. M. JOHNSTON.....	Billings
(Term Expires February 1, 1907.)	
CHARLES R. LEONARD.....	Butte
(Term Expires February 1, 1906.)	
JOHN M. EVANS.....	Missoula
(Term Expires February 1, 1906.)	
G. T. PAUL.....	Dillon
(Term Expires February 1, 1905.)	
N. B. HOLTER.....	Helena
(Term Expires February 1, 1905.)	
S. D. LARGENT.....	Great Falls
(Term Expires February 1, 1908.)	
O. P. CHISHOLM.....	Bozeman
(Term Expires February 1, 1908.)	

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W. M. JOHNSTON.

C. R. LEONARD.

G. T. PAUL.

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W. Y. PEMBERTON.....	Butte
(Term Expires January 1, 1906.)	
JOSEPH H. HARPER.....	Butte
(Term Expires January 1, 1906.)	
WILLIAM A. CLARK, JR.....	Butte
(Term Expires January 1, 1908.)	
H. L. FRANK.....	Butte
(Term Expires January 1, 1908.)	
CHARLES MATTISON.....	Butte
(Term Expires January 1, 1908.)	

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A. W. DEAVETT.....	Secretary
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Professor of Mechanics.

E. H. MACDONALD, E. M.,

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Professor of Chemistry and Metallurgy.

JOHN B. CLAYBERG,

Lecturer on Mining Law.

CHARLES A. DIEHL, B. S.,

Assistant Professor of Chemistry.

LEON R. FOOTE, B. L.,

Instructor of the Preparatory Classes.

JOSEPH ROBERT,

Janitor.

Montana State School of Mines.

HISTORICAL SKETCH.—The foundation for the Montana State School of Mines was laid in the "Enabling Act" in pursuance of which the States of North and South Dakota and the States of Montana and Washington were admitted into the Union.

This Act made an appropriation of forty thousand acres of public land to each of the Dakotas, and one hundred thousand acres to the State of Montana for the establishment and maintenance in each of a State School of Mines. This was the first step taken by our national government for the promotion of institutions devoted to the education of the youth of our country in the specialties that relate to the mining industry. It came as the natural sequence of the Morrill act of 1862, which provided for the establishment of state schools for instruction in agriculture and the mechanic arts. Every state in the Union has organized at least one school under the Morrill act, and the experience of a quarter of a century has shown substantial benefits accruing to the states and the country at large from the adoption of that policy.

The great development of the mining industry in the years immediately following the civil war, and especially the wonderful discoveries of the precious metals in the mountain states of the West gave to the calling of the miner an importance that attached to no other vocation save that of the farmer. It was easily seen that for the successful prosecution of his work the miner still more than the farmer was in need of a special education in the sciences that stand related to his vocation and to the occurrence of ores, and their extraction and proper treatment. It required no profound investigation in political econo-

my to show that the prosperity of all our people was a result in which the prosperity of the miner was a most important factor.

It was on Washington's birthday in 1889 that this "Enabling Act" received the signature of the President of the United States. By this act our government became committed to the policy of promoting schools whose special purpose it should be to educate the rising generation in those branches that tend to fit them to be theoretical and practical miners.

In due time these three states availed themselves of the provisions of the act of 1889. The State of Montana promptly accepted the donation of lands for a School of Mines, and appointed officers to select the amount allowed by the government, and the legislature of the state determined to have the School of Mines established and put in operation as soon as the necessary preliminaries could be arranged. It chose the city of Butte, the great mining center of the state, as the location for the school and appointed a commission consisting of five persons to prepare plans and specifications for the erection of buildings for its accommodation, and to contract for and supervise their construction.

This commission was composed of Hons. F. E. Sargeant, John Gillie, W. W. Dixon, J. H. Leyson and Charles W. Goodale.

The plot of ground upon which the School of Mines building was erected is made up of portions of the Mint lode, donated for the purpose by Gen. Charles S. Warren; the Vanderbilt lode, donated by Messrs. George H. Casey, Levi J. Hamilton, R. H. Wearing, Joseph R. Silver and Robert A. Day; and of the Montrose Addition, donated by Henry Haupt and others. The dimensions of this plot are 376 feet in breadth by 500 feet in length. It is located near the western boundary of the city on the southern bench of "Big Butte." The situation commands a fine view of the city and surrounding country and with the early completion of the city railway will be easy of access to the mining, the business and the residence portions of the city.

The School of Mines building was erected in 1896-7. Its

dimensions are 94 feet by 118. It is three stories high, with a spacious unfinished attic which is practically equivalent to another story. The foundation story is of stone. Those above are of brick. It is nearly, but not absolutely fire-proof. The floors of the lower or basement story are of cement. The stairways are of stone resting on stone pillars and arches of brick. The halls are floored with tile laid in cement and metallic lath were used in plastering. The plan of the building was well conceived, and it is often spoken of as the most substantial public structure in the state. No part of the expense for the erection of this building was borne by the state. The legislature authorized the issue and sale of thirty-year bonds to the amount of \$120,000. These bonds bear interest at the rate of 5 per cent, and are redeemable after fifteen years. The state pledges the donated lands and all the income derived in any way therefrom to the redemption of these bonds, and further pledges itself to make good any deficiencies in the payment of interest, charging back, however, any sums that may be thus advanced to the landed endowment of the institution. The bonds were sold at par August 20, 1900. The monies that had been needed from time to time in the erection of the building were advanced by citizens of Silver Bow county, and these monies have now been refunded, or are being refunded from the proceeds of the bond sale.

ORGANIZATION OF THE SCHOOL.

The legislature at its Session in 1899 contemplated the opening of the school for the reception of pupils at some time in the year 1900, and made an appropriation of \$26,300 for the equipment of the building and for the maintenance of the school to the end of the fiscal year, November 30, 1900.

The trustees of the school at their meeting May 2, 1900, proceeded to elect a president, and instructed him to prepare and submit a plan of organization. His report, which was adopted, set forth:

1. That the aim and scope of the School of Mines was determined by sections 1570 and 1577 of the Political Code of Montana, and that the evident intention of the law was that this institution was designed solely for the purposes mentioned in those sections and not to duplicate unnecessarily any part of the educational work of other State Institutions.

2. That four professorships should be created, viz:

A Professorship of Mathematics, (To be in charge of the President.)

A Professorship of Chemistry and Metallurgy.

A Professorship of Mechanics and Mining Engineering.

A Professorship of Mineralogy, Geology and Mining, and to these should be added an Instructorship in Draughting.

3. That in view of the fact that in the course of a few years these professorships would have to be subdivided, the Board of Trustees in filling these chairs should take into consideration, primarily, the qualification of the applicants for these positions in respect to the first topic mentioned in the title of each professorship.

4. A general outline of a course of study and the subdivision of the work between the different Professors to be chosen.

The course of study outlined was to some extent modeled after that which for some years had been in successful operation at the Colorado School of Mines, and with this was combined some features of the course adopted at the Michigan School of Mines.

5. That the unsurpassed facilities offered by the City of Butte for the practical observation of various processes in Mining and Metallurgy should be duly considered and that the methods of instruction here to be employed should be such that special effort should be made to familiarize its students with the practical work in those lines.

It was noted that ever since the inauguration of Mining Schools, it has been asserted by the Superintendents and Mana-

gers of Mines that the graduates of these schools, though well instructed in scientific and theoretical matters, were to a large extent unprepared to take responsible positions as mining engineers without a further and somewhat extended practical experience in the mines.

The American Institute of Mining Engineers, through the medium of papers, read and published by that body, have urged that the courses in these schools should be so arranged as to fit their graduates more fully for active duty as mining engineers.

It was felt that the Montana School of Mines should endeavor to meet this demand so far as the means at its disposal would permit.

Since the opening of the school this organization has been changed in three respects.

1. By the consent of the Board of Education, given at its meeting in December, 1900, a Preparatory Department, under proper restrictions, was established. This was not designed to do general elementary educational work, but only to give such specific preparation as is needed for admission to the Engineering course.

2. The Professorship of Mechanics and Mining Engineering was divided in 1901. Each of these lines thereafter constituting a full Professorship.

3. At the close of the year 1901-2, it was found necessary to add an Assistant Professor in the Department of Chemistry and Metallurgy.

ATTENDANCE.

The School of Mines was opened for the reception of pupils September 11th, 1900. The total number admitted during that year was 39, classified as follows: Freshman 17, Sophomores 3, Junior 1, Special courses 10, Preparatory 8.

The second year began September 10th, 1901. The attendance this year was 62, to-wit: Preparatory 16, Freshman 23, Sophomore 15, Junior 1, Special courses 7.

A night school was opened for the spring semester commencing February 1, 1902. Three lines of study were provided for these courses, namely: Mathematics, Chemistry and Mineralogy. The numbers availing themselves of these courses were respectively, 6 in Mathematics, 25 in Chemistry, and 14 in Mineralogy.

At the opening of the third year on September 9th, 1902, the regular work of the institution had so increased that the night school had to be discontinued. The attendance that year was 70, to-wit: Preparatory 11, Freshman 22, Sophomores 12, Juniors 12, Seniors 1, Special courses 12.

For the present year—1903-4, the total attendance has been 73, viz: Preparatory 9, Freshman 17, Sophomores 13, Juniors 11, Seniors 10, Special courses 13.

INCREASED ACCOMMODATIONS.

The need of enlarged accommodations was brought to the attention of the General Assembly of the State at its session in 1903, and the sum of \$5,500.00 was appropriated for the purpose. With this sum there has been added, beside numerous minor facilities a fine range consisting of assaying furnaces of the latest and most approved pattern and a reverberatory roasting furnace, which can also be changed to a muffle roasting furnace. These furnaces are adapted to the use of coal and have been in operation since the beginning of this calendar year. They have given entire satisfaction and are proving more economical than where gas has been used for these purposes. Enlarged space has been obtained for the classes in Engineering and Petrography by the completion and furnishing of the large attic story of the School of Mines building. This space was left simply as an attic or garret by the State Building Commission but was so high and

spacious that it seemed well adapted for profitable use. Four large rooms have been fitted up here. The first thirty by thirty-one feet, which is to be used as a laboratory for the class in Petrography. The second is twenty-five feet square and is to be used for the preparation of thin sections of ores and rocks and for the microscopic measurements of the angles of crystals. The third is sixty by thirty-one feet in size and will be used as a draughting room by the classes in Engineering. These rooms are about twelve feet in height and are well lighted, skylights being so placed as to face the north, thus avoiding the direct rays of the sun. The fourth room is 115 feet by 24 and is designed as a storage room for Engineering models of mining and ore dressing machinery and for the installation of such ore dressing processes as can be properly placed in this building. These new rooms will be ready for use at the opening of the fifth collegiate year on the 9th of September, 1904.

FINANCIAL RESOURCES.

The financial resources of the School of Mines consist of the Legislative appropriations which are made from time to time and the Congressional grant of 100,000 acres of land. The Legislative appropriations for maintenance and improvements for the fiscal years, Nov. 30, 1902, to Nov. 30, 1904, amount to \$51,864.94.

On the 15th of April, 1904, the Register of the Land Office reported that 99,206.40 acres of the land grant had been selected, leaving 793.60 acres yet to be claimed. Only 1,646.79 acres of this land had been sold at that date, but 65,554.68 were under lease and the income therefrom is a little more than sufficient to pay the interest on the bonds that were sold to secure money to erect the School of Mines building. The income from this source for 1903 was \$6,499.25. As the interest on the bonds is only \$6,000.00 per year the receipts above show that some surplus is accruing toward the final payment of the bonds. The

State Treasurer's books show a balance in the School of Mines Building, Interest and Sinking Fund of \$19,056.10, which is available for the payment of interest and for the redemption of bonds as soon as the time comes when they can be redeemed.

CONDITIONS OF ADMISSION.

The School of Mines is open on equal conditions to all residents of Montana without regard to sex or race, and to the youth of other states and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be seventeen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra through the first twenty-three chapters in Wentworth's Higher Algebra (or an equivalent), plane, solid and spherical geometry, geography, elementary zoology or physiology, physical geography and English composition.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right, at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

Those who may be qualified for admission to some of the studies of the regular course, but are deficient in preparation for other studies, may be admitted and receive instruction under Mr. Foote in those branches in which their preparation is deficient.

Graduates from the accredited high schools of the state will be admitted without examination, on presentation of their diplomas.

LIST OF ACCREDITED HIGH SCHOOLS.

County High Schools:—

Beaverhead
Broadwater
Carbon
Fergus
Flathead
Gallatin
Jefferson
Park
Powell
Teton

City High Schools.—

Anaconda
Billings
Butte
Forsythe
Glendive
Great Falls
Hamilton
Helena
Miles City
Missoula

COURSE OF STUDY AND DEGREE.

The course of study as outlined on the following pages covers four years and embraces those branches which are considered most important to the mining engineer. Those who complete the course will receive the Degree of Engineer of Mines.

COURSE OF STUDY.

Freshman Year.

FIRST SEMESTER—Hours per Week.

Higher Algebra.....	5
Trigonometry, Plane and Spherical.....	4
General Chemistry—	
Lecture.....	1
Laboratory.....	6
Quiz.....	1
English.....	3
Mechanical Drawing.....	9

SECOND SEMESTER—

Analytical Geometry	5
General Chemistry—	
Lecture	1
Quiz	1
Qualitative Analysis—	
Lecture.....	1
Laboratory.....	9
English	3
Surveying	3
Mechanical Drawing	6
Surveying, Summer Course of six weeks.	

Sophomore Year.

FIRST SEMESTER—	Hours per week.
Differential Calculus.....	5
Physics	5
Chemistry, Quantitative Analysis—	
Lecture.....	1
Laboratory.....	9
Crystallography and Physical Mineralogy.....	4
Blowpipe Methods	3
Topographical Drawing	3
SECOND SEMESTER—	
Integral Calculus	4
Physics, Lectures and Laboratory.....	6
Chemistry, Quantitative Analysis—	
Lecture	1
Laboratory.....	7 1-2
Descriptive Mineralogy	2
Determinative Mineralogy	4 1-2
Drawing, Machine Design.....	3

Junior Year.

FIRST SEMESTER—	Hours per week.
Mechanics, Analytical and Applied.....	5
Geology, Physical and Historical.....	5
Metallurgy—	
Assaying for 1st 10 weeks.....	9
Technical Gas Analysis and Laboratory work for 8 weeks.....	3
Lectures and Recitations in Metallurgy of Cop- per.....	3
Metallurgical Excursion to Copper Smelters..	2 weeks
Mining	2
Testing Laboratory	3
Drawing, Design and Construction for 8 weeks....	6

SECOND SEMESTER—

Hydraulics	3
Mechanics of Materials	3
Mining	2
Mining Excursions	2 weeks
Mine Surveying, Lectures and Recitations.....	3
Metallurgy—	
Metallurgy of Gold and Silver.....	3
Laboratory; Cyaniding, Chlorination, Roasting	
Ores	3
Metallurgical Excursion to Cyanide Plants....	2 weeks
Geology, Economic	3
Geological Excursions	3
Drawing, Design and Construction.....	6
Practical Mine Surveying and Mining, Summer Course	
of 6 weeks.	

Senior Year.

FIRST SEMESTER—	Hours per week.
Mechanical Engineering of Power Plants.....	3
Graphical Statics	3
Mining	2
Ore Dressing	2
Metallurgy—	
Lectures and Recitations in Metallurgy of Lead	3
Laboratory	3
Excursion to Lead Smelters.....	1 week
Mining Engineering Design.....	6

SECOND SEMESTER—

Mining Engineering	5
Ore Dressing Laboratory.....	3
Metallurgy of Iron, Zinc, etc., Lectures and Recita-	
tions	3
Metallurgical Laboratory	3

Power Transmission	3
One of the following Electives is required.	
Petrography—	
Lectures and Recitations.....	4
Laboratory	6
Metallurgical Design	9

PREPARATORY DEPARTMENT.

It has not been considered advisable to create a general preparatory department here, similar to those connected with other state schools of Montana. The State School of Mines is to be maintained as a technical school and its energies are to be confined within the sphere for which it was established. Preparatory education necessary for entrance to the schools of higher education is provided for in the accredited High Schools of the state. However for the benefit of those who have not the opportunity afforded by a high school for preparation, and for others who may be deficient in some subject necessary to pursue certain courses in this school, the State Board of Education has considered it wise to establish a one-year preparatory course.

Because of the technical character of the courses of the School of Mines much stress is put upon a thorough preparation in mathematical and scientific subjects. The subjects taught are those found in the following program of studies. The methods of instruction are as far as possible similar to those employed in the college courses and are as practical as the nature of the subject demands. It is the aim of the work of the department to prepare the student so that he will feel no embarrassment upon entering the classes of the school proper.

REQUIREMENTS FOR ADMISSION.

An applicant for admission to the preparatory department must be at least sixteen years of age, of sound bodily health and of good moral character. He shall sustain a satisfactory examination in geography, algebra to factoring, and arithmetic, including the metric system. (Satisfactory to mean a grade of 70 on a basis of 100). In lieu of an examination an applicant may present a teacher's county certificate of Montana of equal grade, provided the certificate is in force.

PROGRAM OF STUDIES.

First Semester—

Algebra.....	5
Geometry, Plane.....	5
Physiology.....	3
English.....	3

Second Semester—

Algebra.....	5
Geometry, Plane, Solid and Spherical.....	5
Physical Geography	3
English.....	3

(The numbers refer to the hours per week given to recitation).

COURSE OF STUDY.

Algebra.—Beginning at factoring, the year's work will conclude with the 26th chapter of Wentworth's Higher Algebra. Much attention is paid to simultaneous equations of the first and second degree, to Quadratics, to Series, to Logarithms, and to Graphs. Recitations five hours per week through the year.

Geometry, Plane, Solid and Spherical—Four books of Wentworth's Plane and Solid Geometry will be completed by the close of the first semester, and four more by the close of the second semester, three of which will be in Solid and Spherical Geometry. The student will be required to demonstrate nearly all the exercises found at the end of the first and second books of Plane Geometry and to write out his demonstrations in exercise books. Numerous other exercises will be given throughout the year to illustrate the propositions demonstrated. Recitations five hours per week during the year.

English—The work in this branch will continue through the year and will include English grammar and composition. Much work will be required in written composition. Recitations three

times a week each semester. Herrick and Damon's Composition and Rhetoric for Schools is used as a text.

Physiology—Recitations three hours per week throughout the first semester. Human physiology will be studied for twelve weeks followed by the study of biology for six weeks.

Physical Geography—Gilbert and Brigham's Introduction to Physical Geography is used as a text supplemented by readings from many other authors upon particular parts of geography. Excursions will be taken to seek for illustrations of some of the different subjects studied. Daily observations will be kept, for forty days, of the temperature and barometric pressure of the air, of direction and kinds of winds, of kinds of clouds, and kinds and amounts of precipitation. Graphs of some of the preceding observations will be constructed.

The department has in its possession the following aids to the study of physical geography:

The Government Daily Weather Report.

131 U. S. Geologic and Topographic Maps of the United States.

Two Folios of Physiographic Types,
and access to the publications of the United States Government since 1900 bearing upon physiographic subjects, besides an almost complete set of the reports of the United States Geological Survey. Recitations three times a week, second semester.

DETAILS OF COURSE OF INSTRUCTION.

FRESHMAN ENGLISH.

English—Rhetoric and composition,—Hill's Principles of Rhetoric is used as a text. The writing of many themes and the reading of several works of standard fiction will be required. The aim of the course is two fold: First, to correct many of the prevalent faults found in the composition of students of this class, and second, to lay the foundations for an easy style of composition. Required of all freshman three times per week through both semesters. (Mr. Foote.)

MATHEMATICS.

FRESHMAN YEAR.

ALGEBRA.—Commencing with indeterminate equations in Wentworth's Higher Algebra, attention will be given to the theory and use of logarithms, to Series, to the Theory of Equations, and to the solution of numerical equations. Recitations daily through the term. (President Leonard).

TRIGONOMETRY.—Plane and Spherical Trigonometry will also be taught during the first semester, illustrated by a large number of practical problems. Recitations four times per week. (Mr. Foote).

ANALYTICAL GEOMETRY.—The point and straight line, in a plane. Different Systems of Coordinates. The Conic Sections. Discussion of General Equations of the second degree with two variables. Higher Plane curves. The point and straight line in space. Curved Surfaces and surfaces of revolution. Quantics. Daily recitations during the second semester. (President Leonard).

SOPHOMORE YEAR.

DIFFERENTIAL CALCULUS.—Discussion of the method by limits and infinitesimals. Derivatives of functions. Successive differentiation. Maxima and Minima of functions. Curvature. Involutives, evolutes and envelopes. Asymptotes. Singular points and tracing of curves.

Daily recitations or lectures during the first semester. (President Leonard).

INTEGRAL CALCULUS.—General and definite integrals of differential functions. Rectification of curves and quadrature of surfaces. Differential equations. Preparation of a table of Integrals.—Three lectures and recitations per week through the second semester. (President Leonard).

CHEMISTRY.

GENERAL CHEMISTRY.—The subject of general chemistry is taught by means of a series of experimental lectures given once a week and extending through the entire Freshman year. The course covers rather completely the subject of inorganic chemistry, the student being required to take such notes as will enable him to explain in the class room the principles involved and illustrated on the lecture table. The student is expected to read in connection with the lectures standard works on general chemistry. The lectures are supplemented by text-book work and recitations, extending through the entire year, using a standard work on inorganic chemistry.

Experimental laboratory work is required of each student at his desk, embracing the performance of a selected list of about 75 experiments covering the subject of inorganic chemistry, which must be completed previous to the Christmas vacation. In this laboratory work, the student is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions with each other. This is the foundation



PRIVATE CHEMICAL LABORATORY

upon which his general knowledge of chemistry is based and he is required to keep accurate notes of his work, recording the reactions and principles involved in each experiment.

Text-book.—Richter's Inorganic Chemistry.

Reference books.—Any standard works.

QUALITATIVE ANALYSIS.—The subject of qualitative analysis begins immediately after the Christmas vacation in the Freshman year and continues to the end of the school year. The student investigates the general schemes of analysis by which the various metals are detected and separated from each other; then the acid radicals are isolated and detected.

The course covers the separation of the metals and acids in solutions, dry salts and minerals, and is completed with the analysis of a few standard alloys. The student must become conversant with all the standard methods of separation with the reactions involved, and be able to write and balance equations, and to make a complete qualitative analysis of unknowns without the aid of notes. The spectroscope is used in connection with qualitative work for the detection of the fixed alkalies and the alkali earths.

Lectures in qualitative analysis are given, where the separations are made before the class, in order to facilitate the work and quickly give them correct ideas of rapid manipulation, as well as to warn them of the errors into which they might easily be led. The training of the eye is very essential in this work in order to instantly detect any mistakes and to be able to quickly and accurately interpret results. The lectures are followed by quizzes, where the student is thoroughly drilled in the theoretical part of the work.

Text-book—Prescott and Johnson's Qualitative Analysis.

Reference books.—Any standard works.

QUANTITATIVE ANALYSIS.—Quantitative analysis extends through the whole of the Sophomore year. The work embraces all the work as carried on in the laboratories of the smelters, mills

and mining plants. Our object is to thoroughly equip our students with the requisite knowledge for intelligently and successfully carrying on this work. The various products of the smelters, such as crude ores, calcines, slag, mattes, flue dust, pig iron, steels, etc, are analysed. The course covers thoroughly the subject of mineral analysis, including gravimetric, volumetric and colorimetric methods, the standardization of solutions in acidimetry, alkalimetry and cyanide work, the specific gravity of solids and solutions, by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation room and problems in chemistry solved. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed. The student, after being taught the technical methods of analysis, will be required, as far as possible, to practice rapid methods and perform a large number of determinations and report them in one day, as required in actual smelter practice and mill work.

The laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student has at his desk, water, sink, gas and blast, and the extent of his practical work is limited only according to his ability and industry.

Text-book.—Cairns' Quantitative Analysis.

Reference books.—Any standard authority.

METALLURGY.

The subject of metallurgy begins with the first semester of the Junior year and continues uninterruptedly for two years. The subject is presented in the form of lectures illustrated with lantern slides, with text-book work and recitations, and a large amount of practical work in the laboratory, one afternoon per week for two years being devoted to this study.

METALLURGY OF COPPER.—The study of the metallurgy of copper begins the first semester of the Junior year and continues through the term. It includes lectures and recitations covering thoroughly the entire subject, including the electrolytic refining of copper bullion. Immediately after the subject is treated in the lecture and recitation room, one week is devoted to a practical study of the Smelter and the electrolytic refinery at Anaconda, or the Smelter and electrolytic refinery at Great Falls. Immediately following this excursion, one week is spent in studying the five copper smelters of Butte. Each operation of treatment, of high grade ores directly and low grade ores through the intermediate process of concentration, the production of matte by either the reverberatory or blast furnace, the blowing of matte to metallic copper in the converter or the process of refining matte in the reverberatory refining furnace, the electrolytic refining of copper bullion and the separation and recovery of pure copper, gold and silver, can be studied as it passes through each step in the process of transformation. Nearly all of the various known methods of concentrating, roasting and reduction of copper ores are practically illustrated in the Butte smelters, or in the immediate vicinity, and no better opportunity can possibly be afforded a student for regular or special work in this line, and many take advantage of this opportunity by working in the smelters during vacation time. A detailed typewritten report is required of the class of their study at each smelter.

The subject is at present entirely covered by lectures.

Reference books.—Peters, Schnabel.

ASSAYING.—The subject of assaying begins with the first semester of the Junior year and is finished in ten weeks. We strive to give a very thorough and comprehensive course in this subject and to prepare our students to do accurate work upon entering a commercial laboratory. The subject is presented in the form of lectures and a text book placed in the hands of the student. The practical work consists in the fire assay of gold,

silver and lead in all varieties of crude ores and smelter products, such as copper and lead slags, copper and lead mattes, copper, lead and gold bullion, lead dross and speiss, calcines, flue dust, tailings, the muffle assay of coals, etc.

The laboratory is fitted with the most modern appliances, gas and coal assay furnaces, and melting and retorting furnace. Every convenience is at the command of the student and the most modern and reliable gold and silver balances are used in assay work.

Text-book.—King's Assay Manual.

Reference books.—Brown, Ricketts and Miller.

GAS ANALYSIS.—After the course in assaying is completed, the Junior class take up the subject of technical gas analysis in the form of lectures, quizzes and the analytical work. Analyses are made of air, illuminating gas, furnace gases, etc.

METALLURGY OF GOLD AND SILVER.—The second semester of the Junior year is devoted to the study of the metallurgy of gold and silver from text-books and lectures. The practical work in this line consists in treating a given ore by the cyanide, chlorination, hyposulphite or amalgamation process, with or without roasting, and determining the comparative merits of each method upon this given ore, by check assays and analyses. If his ore is of such a nature that it will not admit of all these methods of treatment, then he uses two or more ores, so as to become familiar with each process. After the completion of the theoretical and practical work, a two weeks excursion is taken to visit the various cyanide and other plants of the state, where a careful study is made of the process and a detailed typewritten report is made by the class of each plant and process investigated.

The laboratory for this work is equipped with ten separate cyanide outfits, a chlorination barrel, an amalgamation plate and a calcining furnace, capable of being used as a reverberatory or muffle roasting furnace.

Text-book.—T. K. Rose's Metallurgy of gold.

Text-book.—Collins' Metallurgy of Silver.

Reference books.—Eggleston, Louis, Eissler, Schnabel, Park.

METALLURGY OF LEAD.—The subject of the metallurgy of lead is taken up the first semester of the Senior year and completed in about 12 weeks. The subject is presented in the form of lectures and text-book work. The theoretical work is followed by metallurgical excursions to the lead smelter at Helena or the lead smelters of Salt Lake City and notes and reports required of the students covering the examinations made at the works.

After the completion of the subject of the metallurgy of lead, the Senior class takes up the subjects of the metallurgy of iron, zinc, cobalt, nickel, aluminum, etc.

The laboratory work of the Senior class during the first semester consists in metallurgical experimentation, the basis of the work being the experiments as given in Howe's "Metallurgical Laboratory Notes."

The laboratory work of the Senior class in the second semester consists in the work of metallurgical design. A given ore, from a certain locality and containing paying quantities of any valuable mineral, is given each member of the class. He analyses it and determines the composition and mineral values, then by suitable tests determines the best method by which the ore should be treated. He then proceeds to design a plant suitable for the reduction of this ore, calculating the cost of the plant, the operating expenses and the cost per ton of metal to place on the market. He makes a complete report of his experiments and gives the reasons for the deductions he has drawn. All original drawings in connection with this work remain the property of the School but the student can make and retain any blue-prints that he may desire.

Text-books.—Hofman's Metallurgy of Lead, Campbell's Manuf. and Properties of Iron and Steel, Ingalls' Metallurgy of Zinc, Richard's Metallurgy of Aluminum.

GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations, receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals.

Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster and fusibility, which will aid the student in the determination of minerals. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE METHODS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and its accompanying apparatus and reagents. It includes, also a discussion of isomorphism, dimorphism and the genesis of pseudomorphs. In the laboratory the student becomes familiar with the reactions of the important elements by means of the use of

known minerals. Brush and Penfield's *Determinative Mineralogy and Blowpipe Analysis* is used in the laboratory. *Sophomore—First Semester.*

DETERMINATIVE MINERALOGY.—This course is wholly laboratory work. The student is given actual practice in the determination of minerals by their chemical and physical characters. He is expected to become thoroughly familiar with the common and important minerals so that he will recognize them at once. For the detailed study of minerals, Brush and Penfield's laboratory text is used. *Sophomore—Second Semester.*

DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This branch of geology treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarryman have to meet. Scott's *Introduction to Geology*. *Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's crust. Scott's *Introduction to Geology*. *Junior—First Semester.*

ECONOMIC GEOLOGY.—In this branch of study the uses and commercial value of rocks and ores are especially emphasized. The course includes a study of the common rock and vein-form-

ing minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution, special districts, and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, cements, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Junior—Second Semester.*

PETROGRAPHY.—This course is introduced by a review of the principles of optics, including the propagation of light, total reflection, refraction, refractive indices, polarization, especially by means of the Nicol prism. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lenses, the camera lucida, and the preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form, crystalline texture, cleavages and parting, color in ordinary and in polarized light, relative refringence, optic axes, axes of elasticity, positive or negative, and uniaxial or biaxial character, relative birefringence, extinction in parallel polarized light, character of interference figures, and dispersion. When the student is able to recognize promptly the important rock-forming minerals he is able to take up the determination and classification of igneous, sedimentary, and metamorphic rocks, chiefly by the aid of the microscope. The course is accompanied by a brief study of the methods of determination of the various elements and minerals by chemical reactions with minute quantities under the microscope. *Senior—Second Semester.*

MECHANICS.

PHYSICS.—The subject of Physics is introduced in the Sophomore year. Throughout the course the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous

problems. He must also attend lectures and demonstrations in which the phenomena are shown, and finally enter the laboratory and make a series of physical measurements. While the whole subject of physics is covered, it is the aim to develop most thoroughly such parts as may add directly to the working knowledge of the mining engineer. The department is equipped with a fine assortment of modern apparatus both for the lecture demonstrations and for the individual work in the laboratory.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are also introduced. Aside from the nature and measurement of heat, its application to the steam-engine is considered, and a study is made of the properties of gases and the transmission of energy by means of compressed air. The work in light includes a study of optical and engineering instruments and of the phenomena developed in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc. During the second semester also the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light are determined and a familiarity is acquired with simple electrical measurements, the running and behavior of motors, the running and characteristics of dynamos, etc.

ANALYTICAL AND APPLIED MECHANICS.—A study of these subjects is commenced early in the course in connection with the drawing. Throughout the course the students are required to put into practice the principles and working knowledge acquired in the text-book study and in the lectures.

The work of the Sophomore year consists of a study of the mechanism of machinery, mechanical movements, modes of communicating motion, etc. This work is carried on in the drawing room and is described more fully under the head of **Drawing**.

During the Junior year an extended study is made of Analytical and Applied Mechanics, particular attention being paid to such topics as are useful in the designing of machinery and structures connected with mining and mill work. The first semester is occupied in part by a study of Elementary Statics, Kinematics and Kinetics. The course in Statics deals with conditions of equilibrium, composition and resolution of forces acting on a rigid body, center of gravity, friction, principle of virtual velocities, simple machines, the funicular polygon, etc. After a brief analytic treatment of Kinematics, problems involving the principles are studied; pure rolling in direct-contact mechanisms, frictional gearing, outlines of gear teeth, cams, linkwork, belts, ropes, etc. The subject of Kinetics embraces the laws of motion, impact, moments of inertia, rotary motion, etc.

The second semester is given up to the study of the Mechanics of Materials. Application is made to the study of the resistance and elasticity of materials, to the proportioning of pipes, cylinders, and riveted joints, to cantilever beams, simple beams, restrained beams continuous beams, columns, torsion and shafts, combined stresses, the resilience of materials, torsion and compression, flexure of beams, shear and torsion, apparent stresses and true stresses, etc.

MECHANICAL ENGINEERING OF POWER PLANTS.—The discussion of the power plant is preceded by a course of lectures and recitations on Thermodynamics. Attention is paid to the definitions and units in the domain of heat, work, and power. The laws of thermodynamics are thoroughly developed and numerous problems are solved in connection. The properties of steam are studied and a working knowledge of the temperature-entropy diagrams is acquired. Following this course a systematic study is made of the mechanism of engines, non-condensing, condensing, simple, and continuous expansion engines, valves, and valve gearing with their various governing attachments, engine foundations, bed-plates, etc. Steam boiler types are studied together with their setting, management, etc. The designing and con-

struction of chimneys and the general plans for power houses are also made a part of this course.

GRAPHICS.—The work in Graphics follows the Junior course in Mechanics. The course is intended to familiarize the student with graphical methods of obtaining the stresses in the members of any of the common structures intended to support a load above an opening,—a roof, bridge, or truss. A detailed study is made of the proportions of the various standard roof trusses, attention being given to loads due to materials, wind, snow, etc. Analysis is made of single-span trusses of various types with horizontal chords, trusses with inclined chords, and continuous trusses. In these problems concentrated and uniform loads are considered, stresses due to a locomotive, also stresses due to wind, etc. The work is carried out in the drawing room supplemented by lectures.

POWER TRANSMISSION.—The extensive use of electric power together with the abundant water supply for power purposes in the West have prompted us to give rather extended attention to this branch of engineering. The elementary principles are laid down during the Sophomore year. In the Senior year the students' attention is directed to the general conditions of power transmission, power transmission by continuous current, some properties of alternating circuits, power transmission by alternating currents, synchronous and induction motors, current reorganizers, hydraulic development, the organization of a power station, line construction, centers of distribution, the commercial problems, and measurement of electrical energy. The numerous electric plants about Butte offer opportunities for observing most excellent practice in this line of engineering.

TESTING LABORATORY.—One afternoon each week during the first semester is given to work in the testing laboratory. The course is designed to cover experimentally the formulas derived in the courses in mechanics and to investigate the elastic proper-

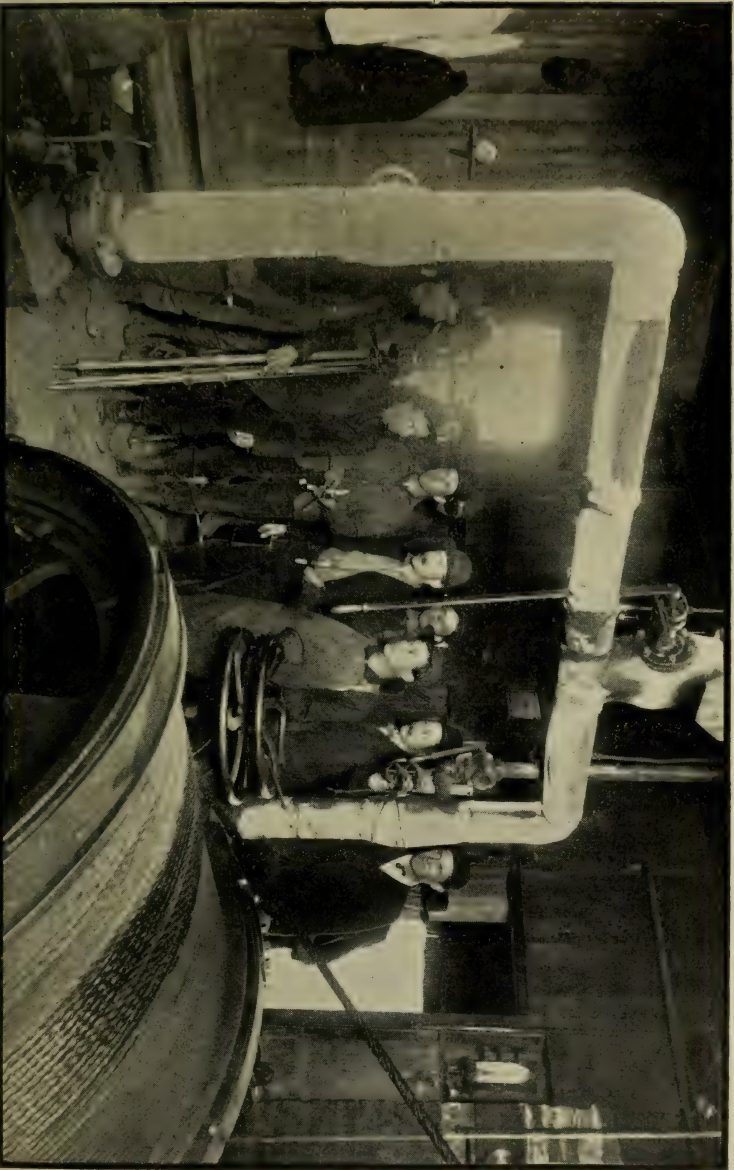
ties of building materials. The students are required to make up standard forms of iron, steel, etc., for tensile, tranverse, and compression tests. Building stone, brick, cement, and timber are investigated. A part of the course consists in making dynamometer tests of an engine and in determining the characteristics of dynamo machinery.

DRAWING AND DESIGNING.—The primary object of instruction in these subjects is to develop the skill necessary in the practice of the engineer, to this end a portion of each term through the whole course is spent in the drawing room working out problems which go hand in hand with class room work. The major part of the work is therefore confined to mechanical and topographical drawing, at the same time it is designed to develop neatness and speed.

When providing himself with drawing instruments it is recommended that the student should purchase only those of good grade; a substantial set of instruments if well cared for, will last throughout the course and for many years of subsequent practice; cheap and inferior instruments are a source of annoyance and loss of time.

The following list of instruments is recommended, other minor necessities may be supplied as suggested.

- One $5\frac{1}{2}$ -inch compass.
- One $3\frac{1}{4}$ -inch bow spacer.
- One $3\frac{1}{4}$ -inch bow pencil.
- One $3\frac{1}{4}$ -inch bow pen.
- One 5-inch ruling pen.
- One 6-inch metal protractor.
- One 8-inch $30^{\circ}\times 60^{\circ}$ amber triangle.
- One 8-inch 45° amber triangle.
- One K. & E. curve No. 20.
- One triangular scale graduated to 12ths.
- One T square, 36-inch blade.
- One board, 24x32 inches.



MINE SURVEYING—READY TO GO DOWN

MECHANICAL DRAWING.—During the first semester of the Freshman year the student recites three hours each week on the problems of Descriptive Geometry and applies himself six hours each week in the drawing room working problems involving projections, sections, intersections, developments, etc.

Six hours per week through the second semester are assigned to making isometric and oblique projections, lettering, tinting, conventions for woods, metals, masonry, etc. Plans, elevations and sections of some simple structure are also completed.

MACHINE DESIGN.—The subject of Machine Design occupies three hours per week during the second semester of the Sophomore year and six hours per week for eight weeks during the first semester of the Junior year. The work consists of the designing and drawing of standard parts of machines. Each problem requires the working out of the part for a specified use, examples of which may be examined on some of the School's machinery. The course includes the designing of screws, nuts, bolts, keys, cotters, gibs, rivets and riveted joints, shaft couplings, bearings, gearing, engine details, etc.

MINING AND MINING ENGINEERING.

Instruction in mining and mining engineering is given by lectures and recitations, by laboratory work, by excursions to mines within easy reach of the students and by practical work during the summer vacation.

An outline of the work is as follows:

ELEMENTS OF MINING.—Lessons are assigned on the geographical and geological distribution of the ores of the useful metals. The subjects of prospecting, locating and acquiring title to mining claims are next considered. Then follows a course of lectures designed to familiarize the student with the nomenclature of the subject and to outline to him the principal methods of

exploitation. Two hours a week. *First Semester—Junior year.* Foster's Ore and Stone Mining.

MINING.—In this course lessons are assigned running parallel with the lectures. The work is illustrated by drawings, prints and models and by frequent visits to local mines where mining operations are observed.

The subjects covered include boring, breaking ground, supporting excavations, exploitation, winding, transportation, drainage, ventilation and illumination.

Two hours a week.—Junior year and first semester of Senior year. Foster's Ore and Stone Mining.

MINE SURVEYING AND MINING.—The work comprises a course of lectures on mine surveying with drawing room work in the solution of numerous problems, exercises in platting and a study of mine models, followed by practical work in the execution of mine surveys and study of mining operations. The school has not only models of different mines, but, in one case, no less than four different models of the same mine; hence the comparative merits of model types can be studied to advantage.

Of the six weeks devoted to practical work, three are spent in making a survey and preparing the maps of some mine. The remaining three weeks are devoted to the study of coal and metal mining operations at the mines.

Three hours a week, second semester—Junior year, and fifty hours a week, six weeks, Junior vacation.

MINING ENGINEERING.—Instruction is given by lectures and recitations, study of professional papers, and excursions to mines in Butte and vicinity. The following is an outline of the course:

MINE PLANT.—The design and arrangement of plant including boiler plant, hoist head frame, underground and surface ore bins, compressor, trackage, means of lighting, ventilating, signalling, pumping, timber framing and repairing.

OPERATION.—Organization, management and accounting. Leases, options, royalties. Examination and reports.

Five hours a week, second semester—Senior year.

ORE DRESSING.—Lectures, recitations and laboratory work on the art of Ore Dressing and ore dressing machinery.

Few, if any, localities afford better opportunities for the student to study the details of the dressing of sulphide ores. The managers of local concentration plants have shown the greatest courtesy to the students of the School of Mines. It has been their custom to permit the students to visit their mills and engage in comparative trials of ore dressing machines under the conditions of actual practice.

The subject, in outline is as follows:

ORE DRESSING MACHINERY.—The construction and operation of the principal types of crushers, rolls, stamps, screens, classifiers, jigs, vanners and concentrating tables.

Principles of Ore Dressing, followed by a study of the design and operation of several mills.

Ore Dressing Laboratory. Laboratory work in concentration and practical work in stamp mills.

Two hours a week, first semester of Senior year and three hours a week, laboratory work, second semester of Senior year. Richard's Ore Dressing.

HYDRAULICS.—A knowledge of the subject of hydraulics is of paramount importance to the mining engineer, particularly to him whose field of labor is in the west. In the course as outlined below particular attention is devoted to the study of the subject as applied in the arts of mining and ore reduction. Opportunities for practical work and observation within easy reach of the student of the Montana State School of Mines are unexcelled.

1. Hydrostatics.

2. Theoretical Hydraulics; a study of the laws of the flow of water through orifices, pipes, conduits and canals; water power and water motors.

3. Measurement of water by weirs, (Field practice.)
4. Dams for water supply, mining and power purposes and for impounding tailings.
5. The design of ditches, flumes and launders for supplying ore reduction plants and for the conveyance of wood, ash, tailings and slags.
6. Domestic supply and sewerage for mining camps; pollution of streams by mining or metallurgical refuse.
7. Water rights; location and title under the laws of the State of Montana.

Text-book—Merriman's Treatise on Hydraulics.

Three hours per week, second semester—Junior year.

SURVEYING.—The course begins in the second semester of the Freshman year and is designed to give the student a thorough preparation for the field work at the end of the year. The class room work consists of lectures and recitations on:

1. Surveying instruments; their construction, adjustment, use and care.
2. Forms of field notes for different methods of surveying and levelling; office forms for computations.
3. Reducing and platting the notes in the drawing room (see topographical drawing); computation of areas.

Text-book—Johnson's Theory and Practice of Surveying.

Three hours per week second semester Freshman year.

SURVEYING.—(Theory and Practice.)—Practical work in the execution of surveys with lectures and recitations. One hour each day is spent in the recitation room, the remainder of the time in the field or in the drawing room. The student is required to execute the following surveys and prepare, where necessary, maps, profiles and complete reports.

1. Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain.
2. Adjustment of hand level, compass, wye level, transit and sextant.

3. Reading angles, horizontal and vertical.
4. Traverse survey with compass and chain.
5. Determination of meridian by solar observation and by observation on polaris.
6. Traverse survey with transit and steel tape, angles by repetition, azimuth and by deflections.
7. Official survey of mining claim in application for U. S. patent; returns to consist of letters of transmittal, plat, field notes and computations; in form for transmission to U. S. Surveyor General.
8. Subdivision of a section of the public land according to Manual of Instructions to U. S. Deputy Surveyors.
9. Topographic survey with transit and steel tape.
10. Laying out a townsite, the plat to be prepared in shape for filing with Clerk and Recorder.
11. Levelling for profile and to fix grade, location of bench marks and contours.
12. Staking out excavation for foundation and determining volume of such excavation.
13. Staking out wagon road, irrigation ditch and flume line. Grades given or assumed, volumes to be determined from cross sections, costs to be estimated.
14. Determination of volume of a dam, a reservoir and an ore or waste dump by cross sections and approximately by contours with use of plainmeter.
15. Railroad Survey: A line about 5 miles long is located and cross sectioned.

Text-books—Johnson's Theory and Practice of Surveying.
Searles' Field Engineering.

Fifty hours a week, six weeks, in the summer vacation
Freshman year.

TOPOGRAPHICAL DRAWING.—This subject accompanies the class room work and field work in Surveying. The student is given the field notes of actual surveys, forms for the office work

of reduction are provided, and he is required to reduce and plat the notes. The work comprises:

1. Making topographical signs, for the usual conventional surface representation and including additional conventions required by the mining engineer such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, etc. The methods of the U. S. Coast and U. S. Geological surveys are followed in this work.

2. Map Construction—Making scales, plotting by polar and rectangular co-ordinates, lettering, titles, borders, corners and north points.

Lectures and drawing room practice.

Six hours a week during the first half of the first semester, Sophomore year.

DESIGN AND CONSTRUCTION.—The design and construction of mining and ore reduction machines; cars, skips, cages, brakes, sheaves, drums, pipe lines, receivers, expansion joints, crushers, rolls, screens, jigs and concentrating tables. The application of the student's knowledge of machine design to those machines and appliances forming a portion of the subject matter of the work in mining and ore dressing.

There are available for the student's use a large number of working drawings of various kinds of mining and ore dressing machines; opportunity is afforded by the local shops to observe the work of assembling the details of most machines above mentioned.

Lectures and drawing room practice.

Six hours a week, second semester, Junior year.

MINING ENGINEERING DESIGN.—This course accompanies the work of the student in mining engineering. Beginning with lectures and drawing room practice in the design in wood, metal and masonry, of such structures as are within the ordinary wants of the mining engineer; the work leads up to the design and

arrangement of plant for one or more of the operations of mining or ore dressing.

Lectures and drawing room practice.

Six hours a week, first semester of Senior year.

LECTURES ON MINING LAW.

The proper construction of the mining laws of the United and of the several states is a subject of great importance, not only to the mining engineer, but to all who are interested in the ownership or management of mining property.

For this reason the Trustees of the School of Mines have inaugurated a course of lectures on this subject and secured as the lecturer Judge Clayberg, whose experience in connection with mining litigation, and as lecturer on this subject for Michigan State University, has specially fitted him for this work.

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions are made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter, the opportunity is here presented for daily observation of works whose development and whose product have given to the city of Butte the reputation of being the greatest mining center in the world. Reference is here made to the statistics that appear at the end of this Catalogue.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them, but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place a telephone message is sent to the school and the class and instructor can take the next street car to the plant and arrive in time to witness the event.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

Besides these comparatively short excursions six weeks of field practice in surveying and mining engineering are required at the close of the Freshman and again at the close of the Junior year. During these periods the entire time of the student is given to acquiring, under the direction of the professor in charge, a familiarity with the use and adjustment of engineering instruments and with the best methods of solving the problems that address themselves to the engineer.

EXCURSIONS OF 1903-4.

The following is a list of the excursions that have been conducted during the year 1903-4.

METALLURGICAL EXCURSIONS.

JUNIOR CLASS.—Excursion to the Washoe Smelter and Electrolytic Refinery at Anaconda.—Dec. 28th, 1903, to Jan. 2nd, 1904.

Excursions to the five smelters of Butte.—Jan. 4th to 9th, 1904.

SENIOR CLASS.—Excursion to the East Helena Lead Smelter Nov. 19th, 1903.

Excursion to the U. S. Assay Office, Helena, Nov. 21st, 1903.

MINE SURVEYING—A SQUAD UNDERGROUND



Excursion to Big Six Cyanide Plant, near Gilt Edge, Nov. 23rd, 1903.

Excursion to Gold Reef Cyanide Plant, near Gilt Edge, Nov. 24th, 1903.

Excursion to Barnes-King Cyanide Plant at Kendall, Nov. 25th, 1903.

Excursion to Kendall Cyanide Plant at Kendall, Nov. 26th, 1903.

GEOLOGICAL EXCURSIONS—JUNIOR CLASS. . .

To the Original Mine, Feb. 20th, 1904.

To the Britannia Mine, March 5th, 1904.

To the Alice Mine, March 12th, 1904.

To the High Ore Mine, March 19th, 1904.

To the Mountain View Mine, March 26th, 1904.

MINING EXCURSIONS. SOPHOMORE CLASS.

July 20, to August 28, to Quigley, Mont.; summer course in surveying.

SENIOR CLASS.

June 9 to July 3, Ophir Mine, Butte. Practical work in mine surveying.

July 6, 7, 8.—Original Mine, Butte.

July 9.—Stewart and West Stewart Mines, Butte.

July 10-13.—Rarus Mine, Butte.

July 10-13.—Corra Mine, Butte.

July 14-15.—Leonard Mine, Butte.

July 16.—Pennsylvania Mine, Butte.

Nov. 20.—Big Indian Mine and Mill, near Helena, Mont.

Nov. 23.—Big Six Mine, near Lewistown, Mont.

Nov. 24.—Gold Reef Mine, Gilt Edge, Mont.

Nov. 25.—Barnes-King Mine, Kendall, Mont.

Nov. 26.—Kendall Mine, Kendall, Mont.

EQUIPMENT.

The equipment of the School of Mines has been secured through appropriations made by the legislature of the State. The total sum invested for this purpose now amounts to more than \$30,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The lists that follow represent only a few of the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

MATHEMATICS.—The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of Engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

CHEMISTRY.—In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigating is very great and the successful prosecution of the purpose for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been devoted to the use of this department together with a lecture room on the second floor. In this space three laboratories have been fitted up, one each, for qualitative and quantitative analysis, and a professor's laboratory.

To these have been added a balance room, a store room of laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast, Bunsen burners, a rack for chemical reagents and a cupboard with lock and key, so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The qualitative and quantitative laboratories are sufficient for the accommodation of 48 students each.

The students' balance room is provided with six analytical balances for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls or floor or the building so that the vibration is reduced to a minimum.

The professor's private laboratory and preparation room is equipped with the modern conveniences for carrying on analytical work. In this room all the chemical reagents are prepared for the use of the students in the other laboratories, and all check analyses on the students' work are made. A dark room is connected with this laboratory and is used for photographic work, spectrum analysis and the making of blue prints and lantern slides.

The Chemical Lecture room located on the second floor is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

METALLURGY.—The assay laboratory is situated on the first or basement floor of the building and is equipped with six of the latest modeled coal assay furnaces. There are also two gas assay furnaces which can be used for special work, and a gas retort and

melting furnace for melting bullion, making alloys, retorting amalgam, casting copper and other anodes, etc.

The pulp room adjoins the assay laboratory, where all charges are weighed up and fluxes added. Convenient cupboards are provided for storing samples. The silver and gold balances are located in the same room as the analytical balances and are of the latest approved design, with agate bearings.

The ore dressing room is provided with a Gates crusher, a Low crusher, an Englebach grinder, capable of grinding pulp to 80 mesh, a buckboard, tables upon which to roll samples, and a series of drawers capable of holding 260 twenty-five pound pulp samples. Our supply of assay samples consist of a large number of copper, lead, gold and silver ores, together with mattes, both copper and lead, slags, flue-dusts, calcines, concentrates, tailings and all smelter products from the copper and lead smelters and other plants of the State. Each student is required to collect crush, grind and buck five twenty-five pound samples in the assay course, and to cut down and assay these samples.

In the assay laboratory are located ten separate cyanide outfits for testing 50 to 100-pound lots of ore by the cyanide process. Also a chlorination barrel in which 100-pound lots can be tested by this process. There is also located in this laboratory, a calcining furnace capable of being used as a reverberatory or muffle roasting furnace, where large lots can be simply calcined, or a chlorination roast can be made for the hyposulphite treatment. We have arrangements for treating free-milling gold ores by the amalgamation process, as well as cyaniding the tailings from this process.

Gas analysis is at present carried on in the chemical lecture room. We have a very complete set of Hempel's gas apparatus and analyses are made of gases of combustion, reverberatory and blast furnace, and illuminating gases, as well as air, etc.

Students are not permitted to do any work outside of that outlined in the regular courses, except under the direction of the professor in charge.



ASSAY FURNACES

GEOLOGY. AND MINERALOGY.—To this department has been assigned:—a large room on the first or main floor as a museum, three rooms on the second floor, viz: a lecture room, an office and supply room, and a mineralogical laboratory, and four rooms on the third floor. These rooms are designated as the thin section lathe room, the dark room, the storage room, and the petrographic laboratory.

The museum is occupied by models of mining properties in Butte, a large geologically colored topographic model of the United States, and various collections of minerals, rocks, and fossils. There are six mine models, namely:

1. Black Rock—Niagara model, constructed by R. C. Brown for the Niagara Mining Company.

2, 3. Colusa Parrot—Never Sweat models, made for the Colusa Parrot Mining Company, one model to show the workings and another to show the economic geology of the mines.

4, 5. Colusa Parrot—Never Sweat models, made for the Anaconda Copper Mining Company, (loaned to the school) one being a block model and the other a skeleton model to show the relative direction of the various veins.

6. Colusa Parrot—Never Sweat model, made for the Colusa Parrot Mining Company, showing all the workings to a true scale; to be exhibited at St. Louis in 1904. This model is accompanied by a map of workings in the Colusa Parrot district made for the Colusa Parrot Mining Co.

The museum is mainly occupied by choice collections of minerals and geological specimens. Amongst these may be enumerated:

a. Two ton specimen of copper ore exhibited at Omaha in 1898 by the Anaconda Copper Mining Company.

b. Systematic collection of minerals.

c. Series of fossils representing all geological horizons.

d. Collection of rocks illustrating geological phenomena.

e. Series of ores of economic importance.

f. Series of fossils from the Tertiary basin of Paris.

g. Collection of rocks illustrating all petrographic types.

(The last collections are installed in one oak wall case 25 feet long by 7 feet high by 2 feet wide and four plate glass center cases with oak bases, each 10 feet long by $3\frac{1}{2}$ feet high by 2 feet wide.)

h. Series of 336 thin sections of rocks illustrating all petrographic types.

k. Oriented thin sections of important rock forming minerals.

l. Other thin sections of rocks and minerals, about 300 in number.

The lecture room on the second floor is seated for the accommodation of forty students, is provided with large blackboards, and with geological diagrams and maps.

The office and supply room contains :

a. Library of geology and mineralogy, including complete sets of some important periodicals, all current magazines devoted to these sciences, both American and European, a large number of text books and monographs, and a goodly share of the official geological publications.

b. Collection of common rocks for class study.

c. Extensive collection of minerals, classified according to their chief base present, for class use.

d. Collection of ores of special districts.

e. Three series of crystal models.

f. Collection of minerals for blowpipe analysis.

g. Chemicals and blowpipe apparatus.

h. Hydraulic blast, hood, oven with automatic temperature regulator, combustion furnace, etc.

The mineralogical laboratory is furnished with :

Six modern blowpipe laboratory tables each 11 feet long by 4 feet wide by 5 feet high, provided with water and gas. The table tops are of plate glass with aluminum rims—each table will accommodate six students at one time :—

Complete apparatus for each student.

An analytical balance, two Jolly balances, three Plattner scales, hydraulic blast, hood, Westphal balance, application goniometers, etc.

A collection of minerals to illustrate all their physical characters.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Penfield goniometers for personal use; the department has, further, three sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The elaborate mine models in the museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are operated by means of an electric motor; each student is expected to learn to make his own thin sections of rocks. At the same time several series of thin sections already prepared, including the series with rock samples arranged to accompany Rosenbusch's classic text, are available for study. The latest model French microscopes are employed for the microscopic studies of rocks and minerals.

All the useful accessories for this work are at hand, including the Bertrand lens, the Fedorof inclining stage, the Michel Levy comparateur, the Lacroix axial goniometer, and a microphotographic apparatus. In order to permit ready and convenient use of the last a large dark room has been fitted up in the third story; it serves also for goniometric practice and photographic work.

PHYSICS.—The Department of Physics occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons and is provided with modern lecture-room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy table and apparatus for the measurement of physical constants. Among the measurements that may be made in the domain of mechanics and heat may be mentioned measurements of density, elasticity, the force of gravity, the latent heat of fusion and of evaporation, specific heats, verification of Boyle's law, etc. For the measurements in electricity, galvanometers, resistance boxes with the necessary batteries, keys, etc., are provided.

For the work in light there is provided a spectrometer and an optical bank, together with lenses and attachments for the measurement of focal lengths and for constructing telescopes and microscopes.

ELECTRICAL APPARATUS.—In the basement of the building a dynamo room is provided with an eleven horse-power gas engine from which are belted direct and alternating current dynamos. A switch-board connects these machines with lines running to various parts of the building. A storage battery of ten cells is also connected to the switch-board. For the purpose of making measurements there is provided a collection of Weston volt and ammeters for both direct and alternating currents, rheostats, dynamometers, etc. The electrical laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., neces-

sary for the more exact and complicated electrical measurements. In connection with this laboratory there is a small shop equipped with a thirteen-inch screw-cutting lathe and a set of hand tools for wood and metal working.

TESTING LABORATORY.—The testing laboratory is equipped with a 100,000-pound Olsen machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Olsen compression micrometer especially designed for measuring the compression of stone cubes and other building materials; one Olsen improved deflection instrument for measuring the deflection of beams subjected to a load; one Henning's improved micrometer instrument for measuring the elongation or compression of long specimens. This instrument measures one ten-thousandth part of an inch and the point of contact of the screw is an electric contact through which signal is given.

The gas engine is provided with brakes and the necessary measuring instruments for making a complete mechanical test of the engine.

The calibration of instruments, and the heating values of fuels is made a part of the course and the requisite instruments are provided.

DRAWING ROOMS.—The drawing classes occupy one large well lighted room, 30x60 feet, on the third floor and one room, 30x30, on the second floor. Ample table room and individual drawer room are provided throughout; cabinets for filing drawings and drawing boards are also provided. A large collection of drawings furnished by various manufacturing companies of mining machinery is on hand and used as an aid to the student in developing new work. A collection of parts of machines is gradually increasing. This material is of great assistance to the department in developing the work in machine design.

MINING ENGINEERING.—For the work of students in Design and Construction and in Mining Engineering Design there are

two large and well lighted drawing rooms on the second floor of the building.

A room 32'x108' on the third floor is being fitted to serve as an ore dressing laboratory and model room, in which students of the Senior and Junior classes will have an opportunity to make laboratory tests on the mechanical preparation of ores preparatory to subsequent metallurgical treatment. In addition opportunities will be afforded for the study of the working of mining, ore dressing and hydraulic machines or models of the same.

For the practical work in surveying the following has been provided:—Five engineer's transits; one from Buff and Buff, one from C. L. Berger and Son's, two from Gurley, and one from Keuffel and Esser. Four levels—One from Buff, one from Gurley, one from Keuffel and Esser, and one from Berger. One sextant with artificial horizon, from Gurley; two aneroids by Short and Mason (London), and a collection of minor apparatus including Locke levels, chains, tapes, plummets, shaft plumbing equipment, rods and flags, necessary in carrying on the work of the department.

THE LIBRARY.

Since the beginning of the year Room No. 5 has been fitted up for the accommodation of the library which heretofore had been scattered through the various departments of the school. Some sectional bookcases, a desk, a cabinet of drawers for geologic atlases, and a card cabinet capable of holding 37,800 light weight cards, have been purchased to add to the already large number of book cases and accessories which were in the possession of the school.

The cataloguing of the library is now in progress and will be completed before the opening of the school at the fall semester.

Most of the books of the library have been acquired by gifts from friends of the institution, by binding the current engineering and scientific periodicals to which the School of Mines is a

subscriber, and by the publications of the United States Government. In 1901, through the efforts of Senator W. A. Clark the School of Mines was made a depository for the publications of the government.

The character of the books of the library is largely technical and bears upon subjects which are related to the work of the school.

The library has complete sets of the Transactions of the American Institute of Mining Engineers, the Mineral Industry, and almost complete sets of the publications of the United States Geological Survey, including the annual reports, the bulletins, the monographs, and the geologic atlases, besides the reports of the geological surveys of many of the states. Many of the reports of the geological surveys of Canada, Australia and South Africa are included in the library.

Mrs. James W. Gerard, of New York city, has made a generous donation of three hundred dollars to be expended in the purchase of technical works for the Library. The gift is highly appreciated and it is expected that some very valuable additions will be made to the Library from this source.

MAGAZINES.

The following scientific magazines will be found on the library tables and in the rooms of the members of the faculty, where they may be freely consulted by the students.

Electrical World and Engineer.
Engineering News.
Engineering Magazine.
Machinery.
Mathematical Magazine.
Annals of Mathematics.
Journal of the American Chemical Society.
Berichte d. d. Chemische Gesellschaft.
Journal of the Chemical Society
—London.

Annales de Chimie et de Physique.
School of Mines Quarterly.
Nature.
Science.
Journal of Geology.
American Geologist.
Bulletin of the Geological Society of America.
Neues Jahrbuch f. Geologie, Mineralogie, etc.
Zeitschrift f. Krystallographie.

Zeitschrift f. praktische Geologie.

Petrographische und Mineralogische Mittheilungen.

Bulletin de la Societe Mineralogique de France.

Bulletin de la Societe Geologique de France.

Mines and Minerals.

Transactions of American Institute of Mining Engineers.

Electrician.

Chemical News.

Engineering and Mining Journal.

Iron and Steel Metallurgist.

Genesis of Ore Deposits.

National Geographical Magazine.

Mining and Scientific Press.

American Journal of Science.

Geological Magazine.

Quarterly Journal of Geological Society of London.

Comptes Rendus.

Mineral Industry.

Mineralogical Magazine — London.

The following newspapers are kindly furnished by their publishers free of charge:

The Ravalli Democrat (weekly) Hamilton.

Great Falls Leader (daily) Great Falls.

The Missoulian (daily) Missoula.

Blue Mountain American (weekly) Baker City, Oregon.

The Tribune Review (weekly) Butte.

DONATIONS.

A complete record of all donations received by the School of Mines is kept at the institution in permanent form. The following is a summary list of gifts received from the establishment of the school to the first of May, 1904:

Official scientific reports have been received from:—

Wm. Anderson, Government Geologist.....	Natal, South Africa
E. J. Babcock, State Geologist.....	Grand Forks, N. D.
E. H. Barbour, State Geologist.....	Lincoln, Neb.
R. A. Bell, Director, Geological Survey.....	Ottawa, Canada
A. E. Birge, Director, Geological Survey.....	Madison, Wis.
W. S. Blatchley, State Geologist.....	Indianapolis, Ind.
H. Y. L. Brown, Government Geologist.....	Adelaide, South Australia
John Byrne, Inspector of Mines.....	Helena, Mont.
Samuel Calvin, State Geologist.....	Iowa City, Ia.
W. B. Clark, State Geologist.....	Baltimore, Md.
A. S. Cooper, State Mineralogist.....	Sacramento, Cal.
C. H. Crantz, State Geologist.....	Springfield, Ill.
G. M. Dawson, Director, Geological Survey.....	Ottawa, Ont.
A. T. Dunn, Surveyor General.....	St. Johns, N. B.
J. A. Ferguson, Commissioner, Agriculture, Labor and Industry....	
.....	Helena, Mont.
Leo Gallaher, Acting State Geologist.....	Jefferson City, Mo.
T. W. Gibson, Acting Director, Bureau of Mines.....	Toronto, Ont.
Edward Gilpin, Inspector of Mines.....	Halifax, N. S.
Erasmus Haworth, Geologist, University Geological Survey.....	
.....	Lawrence, Kan.
C. L. Herrick, President, University of New Mexico..	Albuquerque, N. M.
H. P. Kummel, State Geologist.....	Trenton, N. J.
Henry Landes, State Geologist.....	Seattle, Wash.
A. C. Lane, State Geologist.....	Lansing, Mich.
H. A. Lee, Commissioner of Mines.....	Denver, Colo.
A. Gibb Maitland, Government Geologist.....	Perth, West Australia
George P. Merrill, Curator, Dept. Geology, U. S. Nat. Museum.....	
.....	Washington, D. C.
A. Michael-Levy, Director, Geological Survey.....	Paris, France
J. Obalski, Inspector of Mines.....	Quebec, Canada
G. H. Perkins, State Geologist.....	Burlington, Vt.
W. M. Robertson, Provincial Mineralogist.....	Vancouver, B. C.
A. W. Rogers, Government Geologist.....	Cape Town, South Africa
David Ross, Secretary Illinois Bureau of Labor Statistics.....	
.....	Springfield, Ill.
James Russell, Commissioner of Mineral Statistics.....	Lansing, Mich.
Secretary of State.....	Austin, Tex.
J. J. Sederholm, Director Geological Survey of Finland.....	
.....	Helsingfors, Finland
H. J. H. Shott, Under Secretary of Mines.....	Wellington, New Zealand
F. J. V. Skiff, Director, Field Columbian Museum.....	Chicago, Ill.

E. A. Smith, State Geologist.....	University, Ala.
J. C. Smock, State Geologist.....	Trenton, N. J.
W. C. Stubbs, Director, Agricultural Experiment Station.....	Baton Rouge, La.
B. H. Tatem, Assayer, U. S. Assay Office.....	Helena, Mont.
J. J. H. Teall, Director, Geol. Survey United Kingdom.....	London, Eng.
J. Travis, Secretary for Mines.....	Melbourne, Victoria
J. E. Todd, State Geologist.....	Vermillion, South Dakota
C. D. Walcott, Director, U. S. Geol. Survey.....	Washington, D. C.
W. H. Wallace, Secretary for Mines.....	Hobart, Tasmania
F. A. Wilder, State Geologist.....	Grand Forks, North Dakota
N. H. Winchell, State Geologist.....	Minneapolis, Minn.

Official and scientific reports received from:—

Alexander McKay, Government Geologist.....	Wellington, New Zealand
E. F. Pittman, Government Geologist.....	Sidney, New South Wales
J. W. Gregory, Director Geological Survey.....	Melbourne, Victoria
W. R. Anderson, Secretary for Mines.....	Melbourne, Victoria
J. E. Rickards, Ex-Governor of Montana.....	Butte, Mont.

Books, drawings, maps, etc., have been received from:—

Allis-Chalmers Company, Machine Manufacturers.....	Milwaukee, Wis.
H. Foster Bain, Economic Geologist.....	Idaho Springs, Colo.
A. R. Campbell, Attorney.....	Butte, Mont.
C. W. Goodale, Supt. B. & M. Co.....	Butte, Mont.
U. S. Grant, Prof. Geology, Northwestern University.....	Evanston, Ill.
Harper & Macdonald, Civil Engineers.....	Butte, Mont.
G. W. Irvin, Postmaster.....	Butte, Mont.
N. R. Leonard, President, Montana School of Mines.....	Butte, Mont.
H. V. Winchell, Economic Geologist.....	Butte, Mont.
Henry R. Worthington, Pump Manufacturer.....	Brooklyn, N. Y.

Mineral and geological specimens have been received from:—

Anaconda Copper Mining Company.....	Butte, Mont.
George F. Bartlett.....	Cumbermere, Canada
Boston & Montana Consolidated Copper and Silver Mining Company	
.....	Butte, Mont.
C. T. Brown.....	Socorro, N. M.
Butte & Boston Copper Mining Company.....	Butte, Mont.
H. S. Clark.....	Butte, Mont.
R. M. Cobban.....	Missoula, Mont.
Colorado Fuel & Iron Company.....	Denver, Colo.
S. H. Crookes.....	Livingston, Mont.
Crystal Graphite Company.....	Dillon, Mont.
Walter Douglas.....	Bisbee, Ariz.
T. A. Dowdell.....	Encampment, Wyo.
B. H. Dunshee.....	Butte, Mont.
Elling State Bank.....	Virginia City, Mont.
O. L. Farnham.....	Butte, Mont.
John Gillie.....	Butte, Mont.
C. W. Goodale.....	Butte, Mont.
F. T. Green.....	Butte, Mont.
D. F. Hallahan.....	Republic, Wash.

A. Heffern	Sherman, Wyo.
James H. Henley	Leadville, Colo.
J. W. Heywood	Salt Lake City, Utah
Victor G. Hills	Cripple Creek, Colo.
S. S. Hobson	Utica, Mont.
Homestake Mining Company	Leeds, S. D.
Victor Houghman	Butte, Mont.
N. J. Isdell	Pony, Mont.
I. M. Jones	Butte, Mont.
J. E. Jopling	Ishpeming, Mich
N. R. Leonard	Butte, Mont.
E. H. MacDonald	Butte, Mont.
Edward Massing	Holbert, Mont
Paul McGeehan	Austin, Tex.
McCoy & Klein	Belgrade, Mont.
Montana Ore Purchasing Company	Butte, Montana.
Mount Morgan Gold Mining Co., Ltd.	Mount Morgan, Australia
F. O. Nelson	Butte, Mont.
F. C. North	Polaris, Mont.
H. C. Packer	Hamilton, Mont.
A. P. Pohndorff	Butte, Mont.
Reynolds & McDowell	Butte, Mont.
Eugene Ring, Jr.	Butte, Mont.
George H. Robinson	Butte, Mont.
Dr. A. C. Sandberg	Butte, Mont.
R. H. Terhune	Salt Lake City, Utah
James R. Thompson	Butte, Mont.
George W. Tower	Butte, Mont.
W. H. Weed	Butte, Mont.
C. E. White	Butte, Mont.
E. H. Wilson	Butte, Mont.
A. N. Winchell	Butte, Mont.
H. V. Winchell	Butte, Mont.
W. F. Word	Butte, Mont.
Thos. W. Bryant	Butte, Mont.
C. W. Randall	Bozeman, Mont.

Models and machine parts have been received from :

John Ryerson	Chicago, Ill.
Henry R. Worthington	Brooklyn, N. Y.

The Anaconda Copper Mining Company has presented to the Department of Geology and Mineralogy a rock cutting machine and a rock grinding machine, both of large size and in first class condition. The gift includes, also, a complete set of accessories, such as Canada balsam, glass slides, cover glasses, several sizes of emery, etc.

Mr. C. W. Goodale of Butte, Montana, has presented to the Museum his large collection of ores and minerals from various

parts of the West and from Europe. This donation probably includes a thousand specimens, some of which it would be very difficult to replace; it furnishes a good beginning for the working collection of ores of the school.

The Anaconda Copper Mining Company has presented to the Museum a specimen of chalcocite ore from the thirteen hundred foot level of the Never Sweat mine which weighs approximately thirty-five hundred pounds. It is, without doubt, the largest specimen of its kind on exhibition in the world. It formed the chief feature of the exhibit of the company at the Omaha Exposition, whence it was brought and installed at the school wholly at the expense of the Anaconda company. This gift is accompanied by a series of samples illustrating the treatment of the ore at the concentrators and smelters of the company at Anaconda, Montana.

Mr. C. W. Clark of Butte, Montana, has presented to the Museum a remarkably well chosen collection of crystallized gold specimens. It was exhibited at the Columbian Exposition at Chicago in 1893, where it was awarded a medal.

Senator W. A. Clark has presented to the Museum the model of the Niagara and Black Rock mines, constructed by R. G. Brown, and used in the famous Black Rock-Niagara suit some years ago. This model has been held in trust for the School of Mines, since the settlement of the case, by C. H. Moore of Butte, Montana.

Senator Clark has also presented a very elaborate stope model of the Colusa Parrot mine, which with other mine models belonging to the School of Mines constitutes a part of the mineral exhibit at the World's Fair at St. Louis.

The Colusa Parrot Mining Company has presented to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the lawsuit with the Anaconda Company. These are vertical and horizontal section models on glass plates.

The Anaconda Copper Mining Company has loaned to the Museum the two models of the Colusa Parrot and Never Sweat mines used by the company in the law suit with the Colusa Parrot Mining Company. One of these models is a block model in wood, and the other is a skeleton model, showing the veins and workings, also in wood.

These models form an extremely valuable means of instruction, presenting, as they do, a graphic and readily comprehended picture of the workings and geological features of the mines in question.

DONATIONS TO THE DEPARTMENT OF MINING ENGINEERING.

New York Safety Steam Power Co., 113 Liberty Street, N. Y.—Blue Prints of the Worthington Water Tube Boiler.

The Stirling Co., Pullman building, Chicago.—Blue Prints and framed Photographs of the Stirling Safety Boiler.

Lead Lined Iron Pipe Co., Wakefield, Mass.—Samples of Lead Lined Pipe and Pipe Fittings.

Mr. F. A. Jones, Chief Engineer B., A. & P. Ry. Co., Anaconda, Mont.—Blue Prints and Bills of Material for the construction of Flumes, Trestles and Tunnel Linings.

Mr. S. P. Wright, Mechanical Enginner, Butte.—Numerous catalogues of general Mining Machinery and the use of an Engine Indicator and Test Gage for lecture purposes.

Mr. John S. Hickey, Superintendent A. C. M. Co., Foundry Dept., Anaconda, Mont.—Blue Prints of Gen. Mining Machinery.

Gates Iron Works.—Gates Crusher, laboratory size.

Rand Drill Co.—One Little Giant drill and tripod.

Macomber & White.—Samples of hoisting rope.

John A. Roeblings Sons Co.—Mounted samples of wire rope.

John B. Watson, Chief Engineer Tamarack and Osceola Mines, Calumet, Mich.—Samples of Tamarack mill products.

C. W. Goodale, Supt. Boston & Montana Mining Co.—Samples mill products.

D. W. Brunton, Consulting Engineer A. C. M. Co.—Prints of mine timbers.

Ingersoll-Sergeant Drill Co., N. Y.—One 12," 12¼"x14" Straight Line Air Compressor.

Fried Krupp, Magdeburg-Buckau (Germany).—Mounted photographs of mining and ore dressing machinery.

DONATIONS TO THE METALLURGICAL DEPARTMENT.

A complete metallurgical collection from the Washoe Smelter.

A complete metallurgical collection from the American Smelting and Refining Co.'s plant at Helena, Montana.

EXPENSES.

FEES.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.—To secure the state against loss for apparatus that may be broken by the student, a deposit is required of each one, engaged in laboratory work, at the opening of the year. This deposit is placed in the hands of the Treasurer of the Board of Trustees. Each student is charged with the apparatus issued to him. At the close of the year he is credited with such articles as he returns in good order. The balance of this account is then returned to him.

The following is the list of deposits that are required:

FRESHMAN YEAR.

General Chemistry	\$10.00
Surveying	25.00

SOPHOMORE YEAR.

Qualitative Analysis	15.00
Mineralogy	10.00

JUNIOR YEAR.

Quantitative Analysis and Assaying.....	25.00
Mine Surveying	25.00

SENIOR YEAR.

Petrography	25.00
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If at any time before the close of the year the breakage amounts to the sum deposited, a new deposit will be required.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the city of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. Those who find it necessary to economize can avail themselves of opportunities for doing so similar to those they could find elsewhere.

GENERAL INFORMATION.

The city of Butte is universally known as the great mining center of the country, but the day has passed when it is only this and nothing more. Every year brings a large accession of population in which the best and most intelligent classes of the country are largely represented. Its public schools are in a flourishing condition, and nowhere is there a larger attendance in proportion to the population of a school age than here. The Butte which was known a few years ago as only a great mining camp, with a somewhat restless, roving population, living and doing business in rude or temporary quarters, has given place to the modern city, with spacious business blocks, halls, libraries, elegant churches, and many hundreds of residences such as would do credit to any city of its size anywhere. The moral and intellectual atmosphere of the place is such as to make it a desirable place for the location of a modern institution of learning.

The special advantages of the city as the home of a School of Mines grow out of the fact that here, as in no other place in the world, the mining student can obtain from actual observation a practical acquaintance with the latest processes in mining and the reduction of ores.

The mining companies, their officers and employes, all feel a personal interest in the school, and every facility is freely offered for all proper exploration or examination of the mines and smelters that abound here and in this immediate vicinity. When it is known that the city of Butte furnished last year nearly one-fourth of the entire copper product of the world, besides many millions of dollars worth of silver, gold and lead, the magnitude of its mining enterprises will be partially understood. There is every indication that its relative importance as a mining center will increase in coming years. The large area known to be rich mineral ground is growing larger, and its rich ledges of ore are each year being traced down to lower levels. The development already made has in large measure only scratched the surface of things, while

the full revelation of its wealth of resources is reserved for generations yet to come.

The friends of the School of Mines are confident that with such an environment it will soon become one of the most important institutions of its kind in the country. The management of the school confidently invites the patronage of those who desire the education of a mining school either for themselves or their children.

MINING STATISTICS OF THE CITY OF BUTTE.

In support of the preceding statements the following synopsis of various official state and government reports and other information from authentic sources is here given.

BUTTE AS A COPPER PRODUCER.

	Pounds.
World's total production of copper for 1900.....	1,091,621,440
Butte's total production of copper for 1900.....	245,783,551
Total copper production of U. S. for 1900.....	606,117,166

This shows that nearly one-fourth (22.5 per cent) of the world's output of the red metal for that year was secured from the mines of this city.

The yield of gold and silver is also productive of a large annual revenue. The total value of Butte's output of gold, silver and copper for 1900 was \$53,143,763.93; of this total \$39,792,356.90 was derived from copper.

The population of the city and its suburbs is probably not more than 45,000; thus it appears that the value of the mineral product gives an average of more than \$1,200 for every man, woman and child living within its limits.

Not less than 6,500 of the adult male inhabitants of the city find their daily employment in the shafts, stopes and tunnels of the mines, far beneath the surface on which the city is built.

Some one has said that Butte consists of two cities, one above and the other below the surface. The tallest building in the upper



AT REVERBERATORIES, BUTTE REDUCTION WORKS

city is not more than 100 feet high; many of the workshops in the subterranean city are more than 2,000 feet from bottom to top, and the total length of their hallways, shafts and other passages aggregates the enormous sum of 500 miles. The total horsepower of the engines employed in the mines is about 25,000, and the daily output is 9,850 tons. This ore is treated at the smelters of this city and at the smelters of Anaconda and Great Falls. In the former city, which is only 27 miles from Butte, the smelting plant is of recent construction and is probably the largest in the world.

SMELTERS AND MINING PROPERTIES.

We give herewith a partial list of the principal smelters and mining properties in the immediate vicinity of the school:

SMELTERS.

Butte Reduction Works.	The M. O. P. Smelter.
Butte & Boston Smelters.	The Parrot Smelter.
The Colorado Smelter.	Farrell Smelter.

MINING PLANTS.

Name of Mine.	Depth of Workings.	Name of Mine.	Depth of Workings.
Anaconda	1,800 feet	Henry George	230 feet
Bell	1,600 feet	High Ore	2,200 feet
Bellona	600 feet	Iduna	300 feet
Berkeley	800 feet	Jessie	400 feet
Blue Jay	1,000 feet	Leonard	1,200 feet
Brittannia	400 feet	L. E. R.	800 feet
Buffalo	1,500 feet	Little Mina	800 feet
Butte and Iowa	400 feet	Michael Davitt	290 feet
Cambers	230 feet	Minnie Healy	1,100 feet
Clear Grit	500 feet	Modoc	1,000 feet
Colusa Parrot	1,400 feet	Moonlight	1,400 feet
Corra	1,200 feet	Moose	400 feet
Diamond	2,200 feet	Mountain Con No. 1..	2,000 feet
East Colusa	900 feet	Mountain Con No. 2....	1,500 feet
East Gray Rock	1,600 feet	Mountain View	1,800 feet
Ella	600 feet	Never Sweat	2,000 feet
Emma	800 feet	Nipper	1,400 feet
Gagnon	1,800 feet	Nora	400 feet
Gambetta	600 feet	Old Glory	500 feet
Gem	700 feet	Original	1,400 feet
Glengary	700 feet	Original No. 6.....	360 feet
Green Mountain	2,200 feet	Parnell	650 feet

Parrot	1,500 feet	Silver Bow No. 3.....	700 feet
Pennsylvania	1,400 feet	Sinbad	800 feet
Plymouth	350 feet	Sioux Chief	450 feet
Poulin	1,200 feet	Snohomish	350 feet
Ramsdell Parrot	600 feet	Speculator	1,400 feet
Rarus	1,600 feet	Stella	800 feet
Rarus No. 1.....	800 feet	Steward	1,250 feet
Ravin	400 feet	Wake Up Jim	1,000 feet
St. Lawrence	1,800 feet	West Colusa	1,400 feet
Silver King	360 feet	West Gray Rock.....	700 feet
Silver Bow No. 1.....	1,200 feet	West Steward	1,100 feet
Silver Bow No. 2.....	700 feet		

Here in this partial list we have 67 mines whose total depth of working aggregates from 65,000 to 70,000 feet, and whose product in copper alone is nearly one-fourth of the copper product of the world. It is not merely true that these mines are in the near vicinity of the school—they are available to its students for all proper exploration and examination.

CATALOGUE OF STUDENTS—1903-4.

SENIOR CLASS.

Balmforth, Alfred John.....	Butte, Montana
Clark, Clara.....	Butte, Montana
Duling, John Frederic.....	Stonewall, Colorado
Irelan, Arthur Lee.....	Helena, Montana
Kuphal, Henry Emil.....	Butte, Montana
Little, Isabel	Baltimore, Maryland
McRae, Lachlin Donald.....	Sulu, Montana
McGee, John.....	Butte, Montana
Pauly, Peter Leonard.....	Basin, Montana
Tallant, Harry Stillwell.....	Butte, Montana

JUNIOR CLASS.

Archibald, George.....	Butte, Montana
Brinton, Owen F.....	Butte, Montana
Corey, Clarence R.....	Ansonia, Connecticut
Duthrie, John M., Jr.....	El Paso, Texas
Elford, Basil E.....	Anaconda, Montana
Mackel, Louis C.....	Ada, Minnesota
McGuane, Harry H.....	Butte, Montana
Pratt, Paul D.....	Libby, Montana
Schlosser, Alexander R.....	Chicago, Ill.
Stevenson, Leon Clark.....	Alamo, Oregon
VanGundy, Jay.....	Deer Lodge, Montana

SOPHOMORE CLASS.

Dugan, John Francis.....	Butte, Montana
Feeney, Charles W.....	Butte, Montana
Farnham, Leroy S.....	Butte, Montana
Gieser, Herbert S.....	Butte, Montana
Hammond, Nelson.....	Butte, Montana
Hume, Harry G.....	Butte, Montana
Johns, John W.....	Butte, Montana

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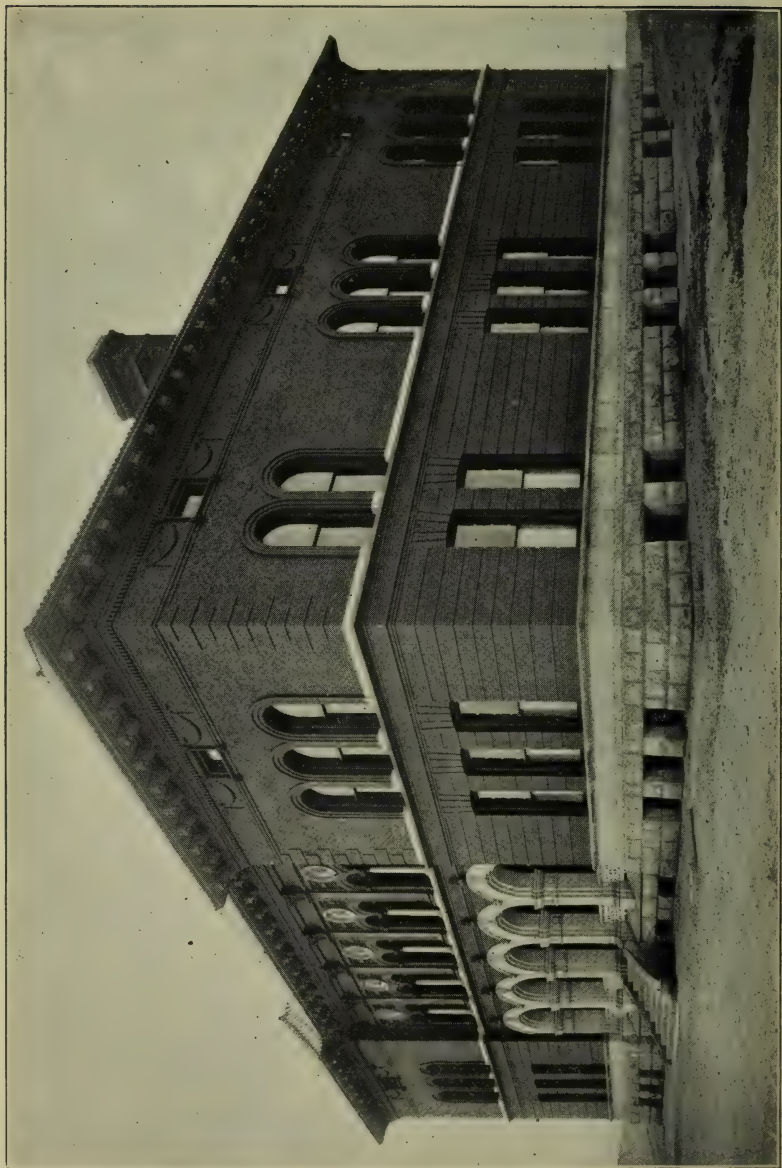
MONTANA STATE SCHOOL OF MINES



FIFTH ANNUAL CATALOGUE
1904-1905

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Montana

State School of Mines

Butte



FIFTH ANNUAL CATALOGUE OF

OFFICERS AND STUDENTS

FOR THE YEAR 1904-1905

WITH ANNOUNCEMENTS FOR THE YEAR
1905-1906



BUTTE, MONTANA

Calendar for 1905-6

1905.

September 8 and 9—Entrance Examinations.

Special Examinations for Conditioned Students.

September 11—First Semester Begins.

November 23 or 30—Thanksgiving—Holiday.

December 22—Holiday Recess to January 8, 1906.

1906.

January 25—Term Examinations Begin.

January 26—End of First Semester.

January 29—Second Semester Begins.

February 22—Washington's Birthday—Holiday.

May—Final Examinations of Senior Class.

June 5—Term Examinations Begin.

June 9—Commencement Day.

June 12—Junior Field Work Begins.

July 24—Sophomore Field Work Begins.

1906-7.

September 10—First Semester Begins.

BOARDS OF CONTROL

STATE BOARD OF EDUCATION

(Ex-Officio.)

JOSEPH K. TOOLE, *Governor of the State.*

ALBERT J. GALEN, *Attorney General.*

W. E. HARMON, *Sup't Public Instruction.*

(Appointed.)

JOHN M. EVANS Missoula
(Term Expires February 1, 1906.)

CHARLES R. LEONARD Butte
(Term Expires February 1, 1906.)

N. W. McCONNELL Helena
(Term Expires February 1, 1907.)

E. O. BUSENBERG Lewistown
(Term Expires February 1, 1907.)

S. D. LARGENT Great Falls
(Term Expires February 1, 1908.)

O. P. CHISHOLM Bozeman
(Term Expires February 1, 1908.)

G. T. PAUL Dillon
(Term Expires February 1, 1909.)

C. N. KESSLER Helena
(Term Expires March 2, 1909.)

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JOHN M. EVANS	Vice-President
J. H. RICE	Treasurer
W. E. HARMON	Secretary

COMMITTEE ON SCHOOL OF MINES.

C. R. LEONARD.

G. T. PAUL.

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JOHN D. SLEMONS	Butte
(Term Expires January 1, 1906.)	
JOSEPH H. HARPER	Butte
(Term Expires January 1, 1906.)	
W. A. CLARK, JR.....	Butte
(Term Expires January 1, 1908.)	
H. L. FRANK	Butte
(Term Expires January 1, 1908.)	
CHARLES MATTISON	Butte
(Term Expires January 1, 1909.)	

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H. C. HOPKINS	Secretary
W. A. CLARK, JR.	Treasurer

OFFICERS OF THE STATE SCHOOL OF MINES

NATHAN R. LEONARD, A. M.,

President and Professor of Mathematics.

ALEXANDER N. WINCHELL, Doctor Univ. Paris,

Professor of Geology and Mineralogy.

CHARLES H. BOWMAN, M. S.,

Professor of Mechanics and Secretary of the Faculty.

ERWIN H. MACDONALD, E. M.,

Professor of Mining Engineering.

WILLIAM G. KING, A. M.,

Professor of Chemistry and Metallurgy.

JOHN B. CLAYBERG, L. L. B.,

Lecturer on Mining Law.

LEON R. FOOTE, B. L.,

Instructor of Preparatory Class.

LESTER J. HARTZELL, E. M.

Assistant Professor of Chemistry.

JOHN S. SCHMIDT,

Assistant in Chemistry.

GEORGE W. CRAVEN, B. S.,

Assistant Professor in Mining Engineering.

JOSEPH ROBERT,

Janitor.

Montana State School of Mines

HISTORICAL SKETCH.

The "Enabling Act," which paved the way for the admission of the territories of Dakota, Montana and Washington into the Union as States, contained a provision for a donation of public lands to each for the "establishment and maintenance of a State School of Mines." The grant to Montana was one hundred thousand acres, and the minimum price at which it was permitted to be sold was ten dollars per acre, thus insuring ultimately a fund of one million dollars for this purpose.

The date of this act was February 22nd, 1889. It was a significant date, and it marks the first plain national provision for education in the interest of the Mining Industry. This legislation was the natural and almost necessary sequel to the Morrill Act of 1862, which provided for the establishment and maintenance of State Colleges for education in Agriculture and the Mechanical Arts.

Mining and Agriculture stand preeminent as factors in the development of the resources of the country and the growth of the nation in wealth and power. It was an enlightened statesmanship that dictated these two systems of education as the best means to secure the best interests of the entire people.

The first Legislative Assembly of the State of Montana appointed Commissioners to select these lands. The last report of the Register of the State Land Office gives the following epitome of the condition of this Land Grant:

Lands selected	99,738.08 Acres
Lands approved	99,211.38 Acres
Lands sold	1,656.16 Acres

This leaves 261.92 acres yet to be selected.

These lands are mainly located in the northwest quarter of the State, and for this reason are not yet saleable at the minimum price fixed by Congress, but the prospective increase of immigration following the development of the many and extensive systems of irrigation planned for our State will soon place some of these lands above the minimum value.

The unsold lands are thus classified in the Register's Report :

Grazing lands	68,428.52 Acres
Timber lands	28,693.16 Acres
Agricultural lands	960.00 Acres

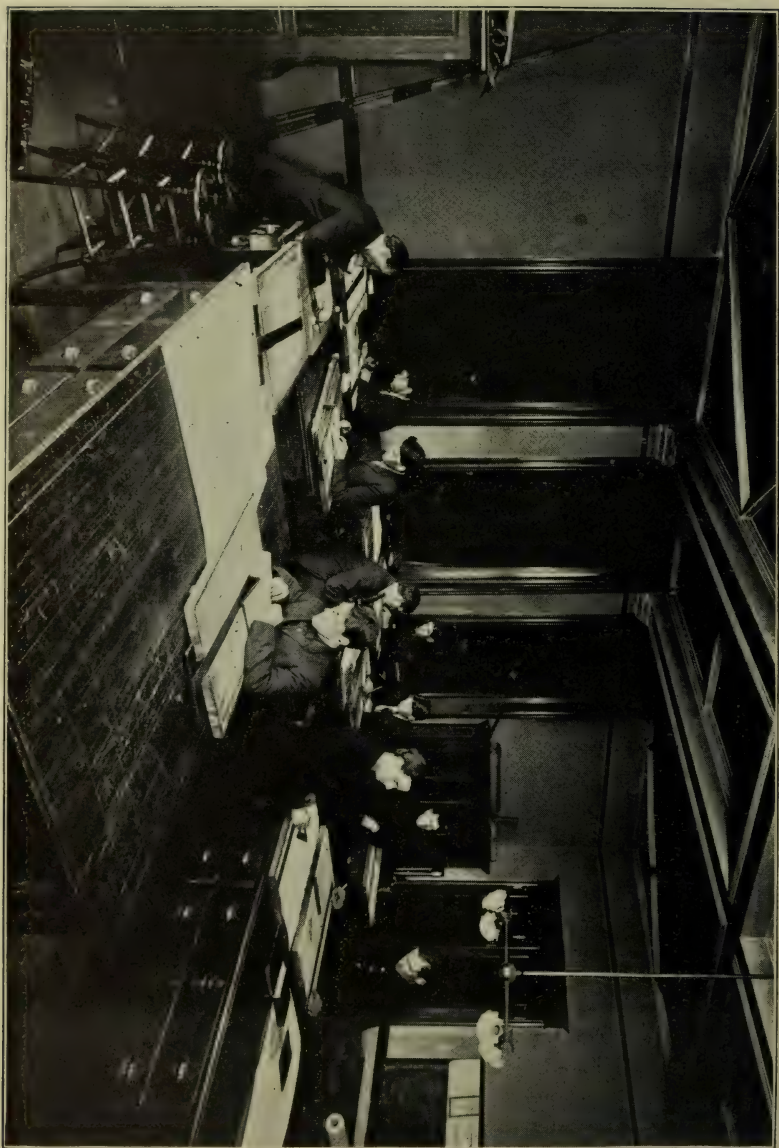
The amount of saw timber on the timber lands has lately been estimated at 120,430,000 feet. This alone can not be valued at less than a quarter of a million dollars.

LOCATION AND ORGANIZATION.

The legislature chose the City of Butte as the location for the State School of Mines. Certain public spirited citizens of Butte donated a plat of ground 376 feet by 500 feet as a building site for the School. This plat is within the present limits of the city and is situated on the southern bench of "Big Butte." It commands a fine view of the city and of the great continental divide which with its valleys and foothills bounds the horizon on the east, south and west.

The first steps toward the organization of the School were taken by the Legislative Assembly in 1895, when a Building Commission was appointed and authorized to issue bonds to secure funds for the erection of a School of Mines Building. These Bonds were not issued till the summer of 1900, but the building was erected in 1896-7; the funds needed for the purpose were advanced by citizens of Butte, and were replaced later from the proceeds of the Bonds.

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IN DRAUGHTING ROOM.

The issue of bonds was \$120,000, bearing 5 per cent interest. They mature in thirty years, but may be paid in fifteen years, at the option of the State. The lands of the School and all the proceeds from lease or sale of the same, are pledged for the payment of the principal and interest of these bonds. At present the leases of these lands is sufficient to meet the interest on these bonds as it accrues. All funds arising from these leases and from the sales of land are paid into the State treasury and placed in a fund known as the "School of Mines Building Interest and Sinking Fund." After the payment of all interest due up to date there remained in that fund at the time of the last report between \$18,000 and \$19,000.

The School of Mines building is of brick, with stone foundation and trimmings. It is four stories high, including the basement. It fronts toward the city and its dimensions are 94 by 118 feet. It contains approximately 37,000 square feet of available floor space and is as nearly fireproof as it was convenient to make it.

The equipment and maintenance of the School is provided by the State through biennial appropriations made by the Legislative Assembly. The sum provided by the Assembly of 1905 was \$28,750 per year for the fiscal period ending November 30th, 1906.

A plan of organization was adopted by the Board of Trustees in the summer of 1900. It set forth :

That the aim and scope of the School of Mines was determined by sections 1570 and 1577 of the Political Code of Montana, and that the evident intention of the law was that this institution was designed solely for the purpose mentioned in those sections and not to duplicate unnecessarily any part of the educational work of other State Institutions.

It established a course of study which was modeled to some extent after that which had for some years been in successful operation at the Colorado School of Mines, but in consideration of the unsurpassed facilities offered by the city of Butte for the practical observation of various processes in

mining and metallurgy, it was determined that the methods of instruction here employed should be such as to familiarize the students with the practical work along these lines.

The Montana State School of Mines was opened for the reception of pupils on September 11, 1900. A Preparatory Department was added in January, 1901, and continued to the present time.

This Department was created to meet a temporary want, which, owing to the gratifying increase in the number and efficiency of the High Schools of the State, no longer exists. Notice is therefore hereby given that at the close of the present College year on June 9, 1905, the Preparatory Department will be discontinued.

BOARDS OF CONTROL.

The control of the entire public school system of the State is by the Constitution vested in the State Board of Education. This Board consists of the Governor of the State, the Attorney General, and the State Superintendent of Public Instruction, together with eight members who are appointed by the Governor and confirmed by the Senate. These last hold their office for four years.

In the case of the School of Mines, the Legislative Act establishing the School provided for a Board of Trustees to be chosen by the Board of Education. To the Trustees is committed the immediate supervision of the School, the adoption of a Course of Study and the election of officers and members of the Faculty, but all the acts of this body are subject to the approval of the Board of Education. The Trustees hold their office for the term of four years.

CONDITIONS OF ADMISSION

The School of Mines is open on equal conditions to all residents of Montana without regard to sex or race, and to the youth of other states and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be seventeen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra through the first twenty-three chapters in Wentworth's Higher Algebra (or an equivalent), plane, solid and spherical geometry, geography, elementary zoology or physiology, physical geography and English composition.

Graduates from the accredited High Schools of the State will be admitted without examination, on presentation of their diplomas; *Provided*, the course of study pursued includes the above topics required for admission to the Montana State School of Mines.

LIST OF ACCREDITED HIGH SCHOOLS.

County High Schools:—

Beaverhead
Broadwater
Carbon
Fergus
Flathead
Gallatin
Jefferson
Park
Powell
Sweet Grass
Teton

City High Schools:—

Anaconda
Billings
Butte
Forsythe
Glendive
Great Falls
Hamilton
Helena
Marysville
Miles City
Missoula

Graduates of the Stevensville Training School and graduates of accepted High Schools in other States will be ac-

cepted on the same terms as those from the accepted High Schools of Montana.

In all cases, graduates of such schools, whether from this or other States, should present with their diploma the course of study from which they graduated with a certificate from the principal of the school as to the course of study pursued.

It is the opinion of the faculty of the State School of Mines that candidates for admission to this school should at least have taken the full four years course required in an accredited High School, or an equivalent course in some other school.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right, at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

COURSE OF STUDY AND DEGREE

The course of study as outlined on the following pages covers four years and embraces those branches which are considered most important to the mining engineer. Those who complete the course will receive the Degree of Engineer of Mines.

COURSE OF STUDY.

Freshman Year.

FIRST SEMESTER—	Hours per Week.
Higher Algebra	5
Trigonometry, Plane and Spherical	4
General Chemistry	3
Laboratory	6
English	3
Mechanical Drawing	9

SECOND SEMESTER—

Analytical Geometry	5
General Chemistry	2
Qualitative Analysis—	
Lecture	1
Laboratory	9
English	3
Surveying	4
Mechanical Drawing	6
Surveying, Summer Course of six weeks.	

Sophomore Year.

FIRST SEMESTER—	Hours per Week.
Differential Calculus	5
Physics	5
Chemistry, Quantitative Analysis—	
Lecture	1
Laboratory	12
Crystallography and Physical Mineralogy..	4
Blowpipe Methods	3

SECOND SEMESTER—

Integral Calculus	4
Physics, Lectures and Laboratory	6
Chemistry, Quantitative Analysis—	
Laboratory	6
Descriptive Mineralogy	2
Determinative Mineralogy	6
Topographical Drawing	6

Junior Year.

FIRST SEMESTER—	Hours per Week.
Mechanics, Analytical and Applied	5
Geology, Physical and Historical	5
Metallurgy—	
Assaying for 1st 10 weeks	9
Technical Gas Analysis and Laboratory	
Work for 8 weeks	3
Lectures and Recitations in Metallurgy of	
Copper	3
Metallurgical Excursion to Copper Smelters.	2 weeks
Testing Laboratory	3
Machine Design	3
Machine Design, Additional for 8 weeks....	6

SECOND SEMESTER—

Hours per Week.

Hydraulics	3
Mechanics of Materials	3
Mining	3
Mining Excursions	2 weeks
Mine Surveying, Lectures and Recitations..	3
Metallurgy—	
Metallurgy of Gold and Silver	3
Laboratory; Cyaniding, Chlorination, Roasting Ores	3
Metallurgical Excursion to Cyanide Plants	2 weeks
Geology, Economic	3
Geological Excursions	3
Drawing, Design and Construction	6

Practical Mine Surveying and Mining, Summer Course
of six weeks.

Field Geology, Summer Course of four weeks.

Senior Year.

FIRST SEMESTER—

Hours per Week

Mechanical Engineering of Power Plants	3
Graphical Statics	3
Mining (9 weeks)	3
Ore Dressing (9 weeks)	3
Metallurgy—	
Lectures and Recitations in Metallurgy of Lead	3
Laboratory	3
Excursion to Lead Smelters	1 week
Mining Engineering Design	6
Petrography—	
Recitations and Lectures	2
Laboratory	6

SECOND SEMESTER—

	Hours per Week.
Mining Engineering	5
Ore Dressing Laboratory.....	3
Metallurgy of Iron, Zinc, etc., Lectures and Recitations	3
Metallurgical Laboratory	3
Power Transmission	3
One of the following Electives is required:	
Petrography	9
Metallurgical Design	9

DETAILS OF COURSE OF INSTRUCTION

FRESHMAN ENGLISH.

ENGLISH.—Rhetoric and composition—Hill's Principles of Rhetoric is used as a text. The writing of many themes and the reading of several works of standard fiction will be required. The aim of the course is two fold : First, to correct many of the prevalent faults found in the composition of students of this class, and second, to lay the foundation for an easy style of composition. Required of all freshman three times per week through both semesters.

MATHEMATICS.

FRESHMAN YEAR.

ALGEBRA.—Indeterminate Coefficients, Theory and use of Logarithms, Limits, Introduction to Derivatives, Binomial and Logarithmic Series, Tests of Convergency of Series, General Theory of Equations, Solution of Numerical Equations. Text-book, Wentworth's Higher Algebra. *First Semester, Daily Recitations.*

PLANE TRIGONOMETRY.—Goniometry, Solutions of Right and Oblique Angled Triangles, Practical Problems, Construction of Trigonometrical Tables, DeMoivres Theorem, Expansion of Sine and Cosine in an infinite series.

SPHERICAL TRIGONOMETRY.—Solution of Right and Oblique Triangles, Napiers Circular Parts and Analogies, Applications of Spherical Trigonometry.

Text-book.—Wentworth's Plane and Spherical Trigonometry. *Four recitations per week during First Semester.*

ANALYTICAL GEOMETRY.—The point and straight line, in a plane. Different Systems of Coordinates. The Conic Sections. Discussion of General Equations of the second degree with two variables. Higher Plane curves. The point and straight line in space. Curved Surfaces and surfaces of revolution. Quantics. *Daily recitations during the Second Semester.*

SOPHOMORE YEAR.

DIFFERENTIAL CALCULUS.—Discussion of the method by limits and infinitesimals. Derivatives of functions. Successive differentiation. Maxima and Minima of functions. Curvature. Involutcs, Evolutcs and Envelopes. Asymptotes. Singular points and tracing of curves.

Daily recitations or lectures during First Semester.

INTEGRAL CALCULUS.—General and definite integrals of differential functions. Rectification of curves and quadrature of surfaces. Differential equations. Preparation of a table of Integrals. *Four lectures and recitations per week through the Second Semester.*

CHEMISTRY.

GENERAL CHEMISTRY.—The subject of general chemistry is taught by means of a series of experimental lectures given twice a week through the first semester and once a week through the second semester. The course covers rather completely the subject of inorganic chemistry, the student being required to take such notes as will enable him to explain in the class room the principles involved and illustrated on the lecture table. The student is expected to read, in connection with the lectures, standard works on general chemistry. The lectures are supplemented by text-book work and recitations, extending through the entire year, using a standard work on inorganic chemistry.

Experimental laboratory work is required of each student at his desk, embracing the performance of a selected list of about 75 experiments covering the subject of inorganic chemistry, which must be completed previous to the Christmas vacation. In this laboratory work, the student is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions with each other. This is the foundation upon which his general knowledge of chemistry is based and he is required to keep accurate notes of his work, recording the reactions and principles involved in each experiment.

Text-book.—Richter's Inorganic Chemistry.

Reference books.—Any standard works.

QUALITATIVE ANALYSIS.—The subject of qualitative analysis begins immediately after the Christmas vacation in the Freshman year and continues to the end of the school year. The student investigates the general schemes of analysis by which the various metals are detected and separated from each other; then the acid radicals are isolated and detected.

The course covers the separation of the metals and acids in solutions, dry salts and minerals, and is completed with the analysis of a few standard alloys. The student must become conversant with all the standard methods of separation with the reactions involved, and be able to write and balance equations, and to make a complete qualitative analysis of "unknowns," without the aid of notes. The spectroscope is used in connection with qualitative work for the detection of the fixed alkalies and the alkali earths.

Lectures in qualitative analysis are given, where the separations are made before the class, in order to facilitate the work and quickly give them correct ideas of rapid manipulation, as well as to warn them of errors into which they might easily be led. The training of the eye is very essential in this work in order to instantly detect any mistakes and to

be able to quickly and accurately interpret results. The lectures are followed by quizzes, where the student is thoroughly drilled in the theoretical part of the work.

Text-book.—Prescott and Johnson's *Qualitative Analysis*.

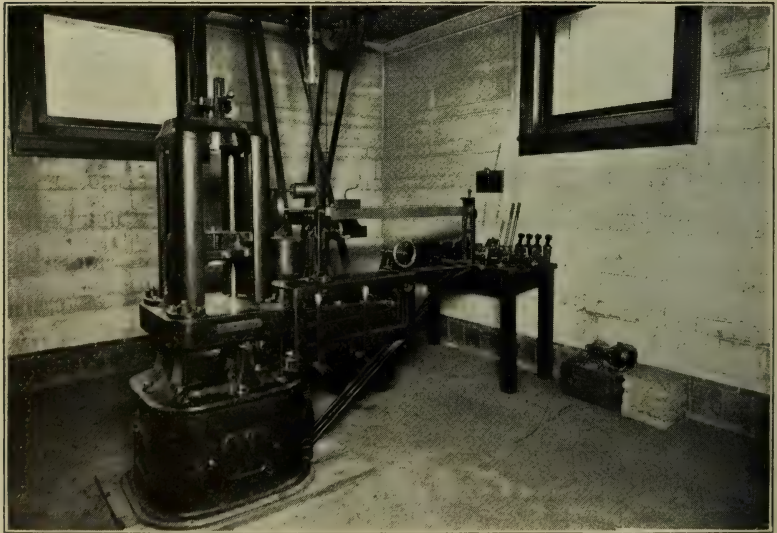
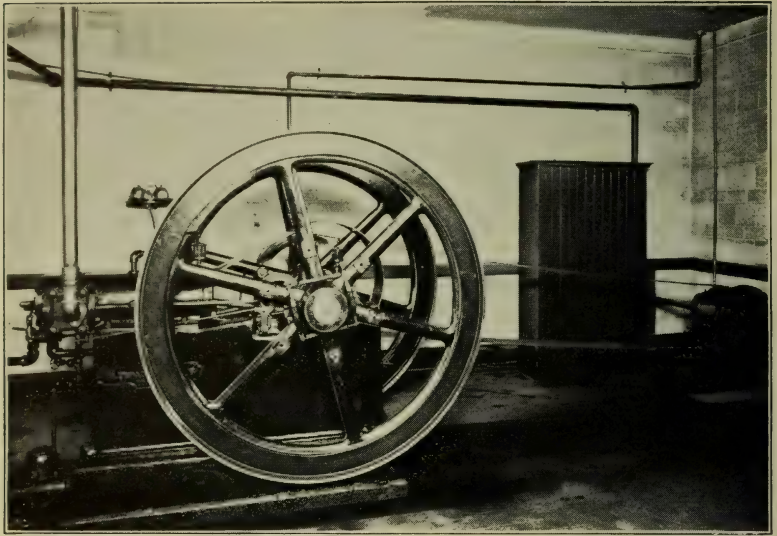
Reference books.—Any standard works.

QUANTITATIVE ANALYSIS.—Quantitative analysis extends through the whole of the Sophomore year. The work embraces all the work as carried on in the laboratories of the smelters, mills and mining plants. Our object is to thoroughly equip our students with the requisite knowledge for intelligently and successfully carrying on this work. The various products of the smelters, such as crude ores, calcines, slag, mattes, flue dust, pig iron, steels, etc., are analysed. The course covers thoroughly the subject of mineral analysis, including gravimetric, volumetric and colorimetric methods, the standardization of solutions in acidimetry, alkalimetry and cyanide work, the specific gravity of solids and solutions, by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation room and problems in chemistry solved. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed. The student, after being taught the technical methods of analysis, will be required, as far as possible, to practice rapid methods and perform a large number of determinations and report them in one day, as required in actual smelter practice and mill work.

The laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student has at his desk, water, sink, gas and blast, and the extent of his practical work is limited only according to his ability and industry.

Text-book.—Cairns' *Quantitative Analysis*.

Reference books.—Any standard authority.



ENGINE AND TESTING ROOM.

METALLURGY.

The subject of metallurgy begins with the first semester of the Junior year and continues uninterruptedly for two years. The subject is presented in the form of lectures illustrated with lantern slides, with text-book work and recitations, and a large amount of practical work in the laboratory, one afternoon per week for two years being devoted to this study.

METALLURGY OF COPPER.—The study of the metallurgy of copper begins the first semester of the Junior year and continues through the term. It includes lectures and recitations covering thoroughly the entire subject, including the electrolytic refining of copper bullion. Immediately after the subject is treated in the lecture and recitation room, one week is devoted to a practical study of the smelter and electrolytic refinery at Anaconda, or the smelter and electrolytic refinery at Great Falls. Immediately following this excursion, one week is spent in studying the five copper smelters of Butte. Each operation of treatment of high grade ores directly, and low grade ores through the intermediate process of concentration, the production of matte by either the reverberatory or blast furnace, the blowing of matte to metallic copper in the converter, or the process of refining matter in the reverberatory refining furnace, the electrolytic refining of copper bullion and the separation and recovery of pure copper, gold and silver, can be studied as it passes through each step in the process of transformation. Nearly all of the various known methods of concentrating, roasting and reduction of copper ores, are practically illustrated in the Butte smelters, or in the immediate vicinity, and no better opportunity can possibly be afforded a student for regular or special work in this line, and many take advantage of this opportunity by working in the smelters during vacation time. A detailed typewritten report is required of the class of their study at each smelter.

The subject is at present entirely covered by lectures.

Reference books.—Peters, Schnabel.

ASSAYING.—The subject of assaying begins with the first semester of the Junior year and is finished in ten weeks. We strive to give a very thorough and comprehensive course in this subject and to prepare our students to do accurate work upon entering a commercial laboratory. The subject is presented in the form of lectures and a text-book placed in the hands of the student. The practical work consists in the fire assay of gold, silver and lead in all varieties of crude ores and smelter products, such as copper and lead slags, copper and lead mattes, copper, lead and gold bullion, lead dross and speiss, calcines, flue dust, tailings, the muffle assay of coals, etc.

The laboratory is fitted with the most modern appliances, gas and coal assay furnaces, and melting and retorting furnace. Every convenience is at the command of the student and the most modern and reliable gold and silver balances are used in assay work.

Text-book.—King's Assay Manual.

Reference books.—Brown, Ricketts and Miller.

GAS ANALYSIS.—After the course in assaying is completed, the Junior class take up the subject of technical gas analysis in the form of lectures, quizzes and the analytical work. Analyses are made of air, illuminating gas, furnace gases, etc.

METALLURGY OF GOLD AND SILVER.—The second semester of the Junior year is devoted to the study of the metallurgy of gold and silver from text-books and lectures. The practical work in this line consists in treating a given ore by the cyanide, chlorination, hyposulphite or amalgamation process, with or without roasting, and determining the comparative merits of each method upon this given ore, by check assays and analyses. If the ore is of such a nature that it will not admit of all these methods of treatment, two or more ores are used, so as to familiarize the student with each process. After the completion of the theoretical and practical work, a two weeks' excursion is taken to visit the various cyanide and other plants of the

State, where a careful study is made of the process and a detailed typewritten report is made by the class of each plant and process investigated.

The laboratory for this work is equipped with ten separate cyanide outfits, a chlorination barrel, an amalgamation plate and a calcining furnace, capable of being used as a reverberatory or muffle roasting furnace.

Text-book.—T. K. Rose's Metallurgy of Gold.

Text-book.—Collins' Metallurgy of Silver.

Reference books.—Eggleston, Louis, Eissler, Schnabel, Park.

METALLURGY OF LEAD.—The subject of the metallurgy of lead is taken up the first semester of the Senior year and completed in about 12 weeks. The subject is presented in the form of lectures and text-book work. The theoretical work is followed by metallurgical excursions to the lead smelter at Helena or the lead smelters of Salt Lake City and notes and reports required of the students covering the examinations made at the works.

After the completion of the subject of the metallurgy of lead, the Senior class takes up the subjects of the metallurgy of iron, zinc, cobalt, nickel, aluminum, etc.

The laboratory work of the Senior class during the first semester consists in metallurgical experimentation, the basis of the work being the experiments as given in Howe's "Metallurgical Laboratory Notes."

The laboratory work of the Senior class in the second semester consists in the work of metallurgical design. A given ore, from a certain locality and containing paying quantities of any valuable mineral, is given each member of the class. He analyzes it and determines the composition and mineral values, then by suitable tests determines the best method by which the ore should be treated. He then proceeds to design a plant suitable for the reduction of this ore, calculating the cost per

ton of metal to place on the market. He makes a complete report of his experiments and gives the reasons for the deductions he has drawn. All original drawings in connection with this work remain the property of the School, but the student can make and retain any blue-prints that he may desire.

Text-books.—Hofman's Metallurgy of Lead, Campbell's Manuf. and Properties of Iron and Steel, Ingalls' Metallurgy of Zinc, Richard's Metallurgy of Aluminum.

GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations, receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals.

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A STUDY IN MINERALOGY.

Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster and fusibility, which will aid the student in the determination of minerals. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE METHODS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and its accompanying apparatus and reagents. It includes, also a discussion of isomorphism, dimorphism and the genesis of pseudomorphs. In the laboratory the student becomes familiar with the reactions of the important elements by means of the use of known minerals. *Sophomore—First Semester.*

DETERMINATIVE MINERALOGY.—This course is wholly laboratory work. The student is given actual practice in the determination of minerals by their chemical and physical characters. He is expected to become thoroughly familiar with the common and important minerals so that he will recognize them at once. *Sophomore—Second Semester.*

DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This course treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarrymen, have to meet. Scott's Introduction to Geology. *Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's crust. Scott's Introduction to Geology. *Junior—First Semester.*

ECONOMIC GEOLOGY.—In this course the uses and commercial value of mineral products are especially emphasized. The course includes a study of the common rock and vein-forming minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Junior—Second Semester.*

PETROGRAPHY.—This course is introduced by a review of the principles of optics, including the propagation of light, total reflection, refraction, polarization and dispersion. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lens and the camera lucida. He must also become acquainted with the method of preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form and habit, cleavages and parting, color and pleochroism, refringence and birefringence, positive or negative, and uniaxial or biaxial interference figures, and their dispersion. When able to recognize promptly the important rock-forming minerals, the student is prepared for the microscopical study of rocks. The course is accompanied by a brief study of the methods of determination of the various elements and minerals by chemical reactions with minute quantites under the microscope. *Senior—First Semester.*

PETROGRAPHY, ADVANCED COURSE.—The chief object of the advanced course in this subject is to train the student to rapidly identify crystalline rocks by means of the microscope. Attention will be directed especially to the igneous rocks. Various systems of classification will be studied, and their fundamental principles compared. The mineral composition, both qualitative and quantitative, the estimated chemical composition and the crystalline texture will demand attention. The student will then study in detail typical examples of each of the important rock families. *Senior—Second Semester.*

FIELD GEOLOGY.—Study of a selected area in the vicinity of Butte. Practice in observing geological features and in interpreting them. Geological mapping. *Summer course of four weeks.*

MECHANICS.

PHYSICS.—The subject of Physics is introduced in the Sophomore year. Throughout the course the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown, and finally enter the laboratory and make a series of physical measurements. While the whole subject of physics is covered, it is the aim to develop most thoroughly such parts as may add directly to the working knowledge of the mining engineer. The department is equipped with a fine assortment of modern apparatus both for the lecture demonstrations and for the individual work in the laboratory.

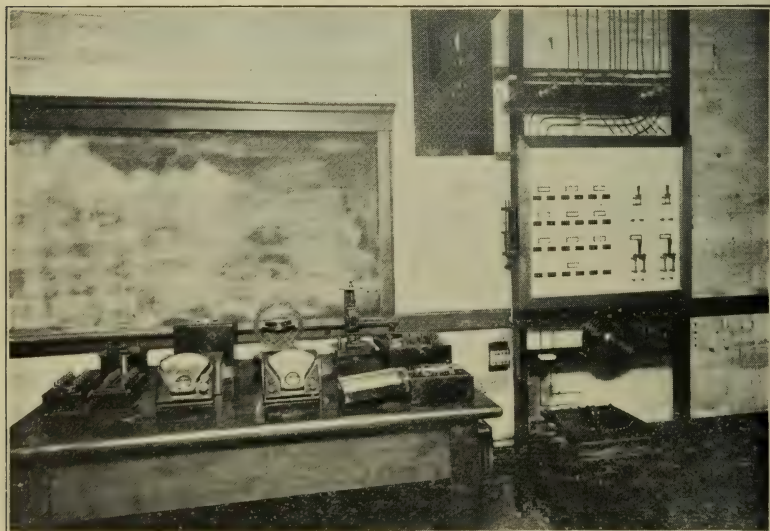
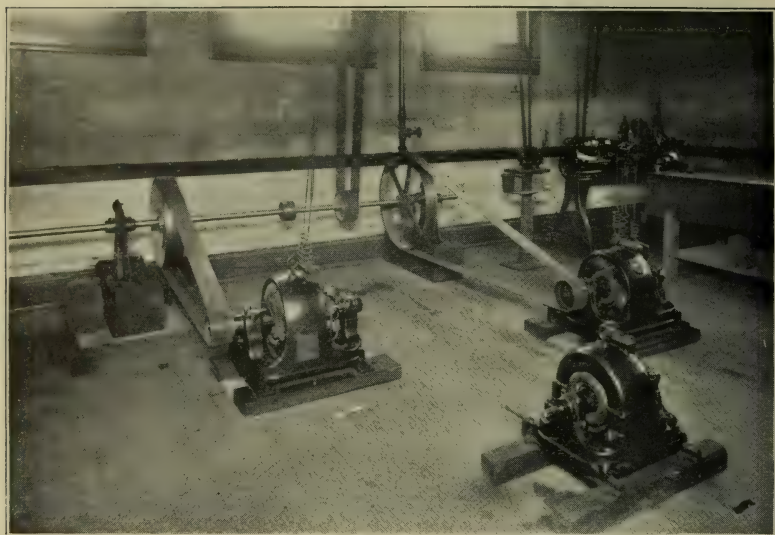
During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are also introduced. Aside from the nature

and measurement of heat, its application to the steam-engine is considered, and a study is made of the properties of gases and the transmission of energy by means of compressed air. The work in light includes a study of optical and engineering instruments and of the phenomena developed in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc. During the second semester also the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light, are determined and a familiarity is acquired with simple electrical measurements, the running and behavior of motors, the running and characteristics of dynamos, etc.

ANALYTICAL AND APPLIED MECHANICS.—During the Junior year an extended study is made of Analytical and Applied Mechanics, particular attention being paid to such topics as are useful in the designing of machinery and structures connected with mining and mill work. The first semester is occupied in part by a study of Elementary Statics, Kinematics and Kinetics. The course in Statics deals with conditions of equilibrium, composition and resolution of forces acting on a rigid body, center of gravity, friction, principle of virtual velocities, simple machines, the funicular polygon, etc. After a brief analytic treatment of Kinematics, problems involving the principles are studied; pure rolling in direct-contact mechanisms, frictional gearing, outlines of gear teeth, cams, linkwork, belts, ropes, etc. The subject of Kinetics embraces the laws of motion, impact, moments of inertia, rotary motion, etc.

The second semester is given up to the study of the Mechanics of Materials. Application is made to the study of the resistance and elasticity of materials, to the proportioning of pipes, cylinders and riveted joints, to cantilever beams, simple



ELECTRICAL EQUIPMENT.

beams, restrained beams, continuous beams, columns, torsion and shafts, combined stresses, the resilience of materials, torsion and compression, flexure of beams, shear and torsion, apparent stresses and true stresses, etc.

MECHANICAL ENGINEERING OF POWER PLANTS.—The discussion of the power plant is preceded by a course of lectures and recitations on Thermodynamics. Attention is paid to the definitions and units in the domain of heat, work, and power. The laws of thermodynamics are thoroughly developed and numerous problems are solved in connection. The properties of steam are studied and a working knowledge of the temperature-entropy diagrams is acquired. Following this course a systematic study is made of the mechanism of engines, non-condensing, condensing, simple, and continuous expansion engines, valves, and valve gearing with their various governing attachments, engine foundations, bed-plates, etc. Steam boiler types are studied together with their setting, management, etc. The designing and construction of chimneys and the general plans for power houses are also made a part of this course.

During this course a series of lectures is offered, essentially descriptive of pumps and pump details, special attention being given to the construction and management of mining pumps. The course is based on, "Pumping Machinery," by William M. Barr.

GRAPHICS.—The work in Graphics follows the Junior course in Mechanics. The course is intended to familiarize the student with graphical methods of obtaining the stresses in the members of any of the common structures intended to support a load above an opening,—a roof, bridge, or truss. A detailed study is made of the proportions of the various standard roof trusses, attention being given to loads due to materials, wind, snow, etc. Analysis is made of single-span trusses of various types with horizontal chords, trusses with inclined chords, and continuous trusses. In these problems concentrated and uniform loads are considered, stresses due to a loco-

tive, also stresses due to wind, etc. The work is carried out in the drawing room supplemented by lectures and recitations.

POWER TRANSMISSION.—The extensive use of electric power, together with the abundant water supply for power purposes in the West have prompted us to give rather extended attention to this branch of engineering. The elementary principles are laid down during the Sophomore year. In the Senior year the students' attention is directed to the general conditions of power transmission, power transmission by continuous current, some properties of alternating circuits, power transmission by alternating currents, synchronous and induction motors, current reorganizers, hydraulic development, the organization of a power station, line construction, centers of distribution, the commercial problems, and measurement of electrical energy. The numerous electrical plants about Butte offer opportunities for observing most excellent practice in this line of engineering.

TESTING LABORATORY.—One afternoon each week during the first semester is given to work in the testing laboratory. The course is designed to cover experimentally the formulas derived in the courses in mechanics and to investigate the elastic properties of building materials. The students are required to make up standard forms of iron, steel, etc., for tensile, transverse, and compression tests. Building stone, brick, cement, and timber are investigated. A part of the course consists in making dynamometer tests of an engine and in determining the characteristics of dynamo machinery.

MINING AND MINING ENGINEERING.

Instruction in mining and mining engineering is given by lectures and recitations, by laboratory work, by excursions

to mines within easy reach of the students and by practical work during the summer vacation.

An outline of the work is as follows :

ELEMENTS OF MINING.—Lessons are assigned on the geographical and geological distribution of the ores of the useful metals. The subjects of prospecting, locating and acquiring title to mining claims are next considered. Then follows a course of lectures designed to familiarize the student with the nomenclature of the subject and to outline to him the principal methods of exploitation.

MINING.—Following the preliminary work outlined above, the subject is considered in detail. Running parallel with the text, lectures and notes are given to the student and the work is illustrated by drawings, prints, models and frequent visits to local mines, where mining operations are observed.

The subjects covered include boring, breaking ground, supporting excavations, exploitation, winding, transportation, drainage, ventilation and illumination.

Three hours each week, Second Semester, Junior year, and for nine weeks First Semester, Senior year. Foster's Ore and Stone Mining.

MINE SURVEYING AND MINING.—The work comprises a course of lectures on mine surveying with drawing room work in the solution of numerous problems, exercises in platting and a study of mine models, followed by practical work in the execution of mine surveys and study of mining operations. The school has not only models of different mines, but, in one case, no less than four different models of the same mine; hence the comparative merits of model types can be studied to advantage.

Of the six weeks devoted to practical work, four are spent in making a survey and preparing the maps of some mine. The

remaining two weeks are devoted to the study of mining operations at the mines.

Three hours a week, Second Semester—Junior year and fifty hours a week, six weeks, Junior vacation.

MINING ENGINEERING.—Instruction is given by lectures and recitations, study of professional papers, and excursions to mines in Butte and vicinity. The following is an outline of the course:

Mine Plant.—The design and arrangement of plant including boiler plant, hoist head frame, underground and surface ore bins, compressor, trackage, means of lighting, ventilating, signaling, pumping, timber framing and repairing.

Operation.—Organization, management and accounting. Leases, options, royalties. Examination and reports.

Five hours a week, Second Semester—Senior year.

ORE DRESSING.—Recitations and laboratory work on the art of Ore Dressing and ore dressing machinery.

Few, if any, localities afford better opportunities for the student to study the details of the dressing of sulphide ores. The managers of local concentration plants have shown the greatest courtesy to the students of the School of Mines. It has been their custom to permit the students to visit their mills and engage in comparative trials of ore dressing machines under the conditions of actual practice.

The subject, in outline, is as follows:

Ore Dressing Machinery.—The construction and operation of the principal types of crushers, rolls, stamps, screens, classifiers, jigs, vanners and concentrating tables.

Principles of Ore Dressing.—Followed by a study of the design and operation of several mills.

Ore Dressing Laboratory.—Laboratory work in concentration and practical work in stamp mills.

Three hours a week, nine weeks, First Semester of Senior year and three hours a week, Second Semester of Senior year. Richard's Ore Dressing.

HYDRAULICS.—A knowledge of the subject of hydraulics is of paramount importance to the mining engineer, particularly to him whose field of labor is in the west. In the course as outlined below particular attention is devoted to the study of the subject as applied in the arts of mining and ore reduction. Opportunities for practical work and observation within easy reach of the student of the Montana State School of Mines are unexcelled.

1. Hydrostatics.
2. Theoretical Hydraulics; a study of the laws of the flow of water through orifices, pipes, conduits and canals; water power and water motors.
3. Measurement of water by weirs (Field Practice).
4. Dams for water supply, mining power purposes and for impounding tailings.
5. The design of ditches, flumes and launders for supplying ore reduction plants and for the conveyance of wood, ash, tailings and slags.
6. Domestic supply and sewerage for mining camps; pollution of streams by mining or metallurgical refuse.
7. Water rights; location and title under the laws of the State of Montana.

Text-book.—Merriman's Treatise on Hydraulics.

Three hours per week, Second Semester—Junior year.

SURVEYING.—The course begins in the second semester of the Freshman year and is designed to give the student a thorough preparation for the field work at the end of the year. The class room work consists of lectures and recitations :

1. Surveying instruments; their construction, adjustment, use and care.
2. Forms of field notes for different methods of surveying and levelling; office forms for computations.
3. Reducing and platting the notes in the drawing room (see topographical drawing); computation of areas.

Text-book—Johnson's Theory and Practice of Surveying.

Three hours per week, Second Semester—Freshman year.

Surveying.—(Theory and Practice.)—Practical work in the execution of surveys with lectures and recitations. One hour each day is spent in the recitation room, the remainder of the time in the field or in the drawing room. The student is required to execute the following surveys and prepare where necessary, maps, profiles and complete reports.

1. Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain.

2. Adjustment of hand level, compas, wye level, transit and sextant.

3. Reading angles, horizontal and vertical.

4. Traverse survey with compass and chain.

5. Determination of meridian by solar observation and by observation on Polaris.

6. Traverse survey with transit and steel tape, angles by repetition, azimuth and by deflections.

7. Official survey of mining claim in application for U. S. patent; returns to consist of letters of transmittal, plat, field notes and computations; in form for transmission to U. S. Surveyor General.

8. Subdivision of a section of the public land according to Manual of Instructions to U. S. Deputy Surveyors.

9. Topographic survey with transit and steel tape.

10. Laying out a townsite, the plat to be prepared in shape for filing with Clerk and Recorder.

11. Levelling for profile and to fix grade, location of bench marks and contours.

12. Staking out excavation for foundation and determining volume of such excavation.

13. Staking out wagon road, irrigation ditch and flume line. Grades given or assumed, volumes to be determined from cross sections, costs to be estimated.



TAKING SUN'S ALTITUDE.

14. Determination of volume of a dam, a reservoir and an ore or waste dump by cross sections and approximately by contours with use of planimeter.

15. Railroad Survey.—A line about 5 miles long is located and cross sectioned.

Text-books—Johnson's Theory and Practice of Surveying.

Searles' Field Engineering.

Fifty hours a week, six weeks, in the summer vacation—Freshman year.

TOPOGRAPHICAL DRAWING.—This subject follows the class room work and field in Surveying. The student is given the field notes of actual surveys, forms for the office work of reduction are provided, and he is required to reduce and plat the notes. The work comprises:

1. Making topographical signs, for the usual conventional surface representation and including additional conventions required by the mining engineer such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, etc. The methods of the U. S. Coast and U. S. Geological surveys are followed in this work.

2. Map Construction.—Making scales, plotting by polar and rectangular co-ordinates, lettering, titles, borders, corners and north points.

3. Platting Notes of Summer Field Work.

DRAWING AND DESIGNING.

The primary object of instruction in these subjects is to develop the skill necessary in the practice of the engineer; to this end a portion of each term through the whole course is spent in the drawing room working out problems which go hand in hand with class room work. The major part of the work is therefore confined to mechanical and topographical drawing, at the same time it is designed to develop neatness and speed.

When providing himself with drawing instruments it is recommended that the student should purchase only those of good grade; a substantial set of instruments if well cared for, will last throughout the course and for many years of subsequent practice; cheap and inferior instruments are a source of annoyance and loss of time.

The following list of instruments is recommended, other minor necessities may be supplied as suggested.

- One $5\frac{1}{2}$ inch compass.
- One $3\frac{1}{4}$ inch bow spacer.
- One $3\frac{1}{4}$ inch bow pencil.
- One $3\frac{1}{4}$ inch bow pen.
- One 5-inch ruling pen.
- One 6-inch metal protractor.
- One 8-inch $30^\circ \times 60^\circ$ amber triangle.
- One 8-inch 45° amber triangle.
- One K. & E. curve No. 20.
- One triangular scale graduated to 12ths.
- One T square, 36-inch blade.
- One board, 24x32 inches.

Mechanical Drawing.—During the first semester of the Freshman year the student recites three hours each week on the problems of Descriptive Geometry and applies himself six hours each week in the drawing room working problems involving projections, sections, intersections, developments, etc.

Six hours per week through the second semester are assigned to making isometric and oblique projections, lettering, tinting, conventions for wood, metals, masonry, etc. Plans, elevations and sections of some simple structure are also completed.

Machine Design.—The subject of Machine Design occupies three hours per week during the first 10 weeks of the first semester, Junior year, and nine hours per week during the remainder of the semester. The work consists of the designing and drawing of standard parts of machines. Each problem re-

quires the working out of the part for a specified use, examples of which may be examined on some of the School's machinery. The course includes the designing of screws, nuts, bolts, keys, cotters, gibs, rivets and riveted joints, shaft couplings, bearings, gearing, engine details, etc.

Design and Construction.—The design and construction of mining and ore reduction machines; cars, skips, cages, brakes, sheaves, drums, pipe lines, receivers, expansion joints, crushers, rolls, screens, jigs and concentrating tables. The application of the student's knowledge of machine design to these machines and appliances forms a portion of the subject matter of the work in mining and ore dressing.

There are available for the students' use a large number of working drawings of various kinds of mining and ore dressing machines; opportunity is afforded by the local shops to observe the work of assembling the details of most machines above mentioned.

Lectures and drawing room practice.

Six hours a week, second semester, Junior year.

Mining Engineering Design.—This course accompanies the work of the student in mining engineering. Beginning with lectures and drawing room practice in the design in wood, metal and masonry, of such structures as are within the ordinary wants of the mining engineer; the work leads up to the design and arrangement of plant for one or more of the operations of mining or ore dressing.

Lectures and drawing room practice.

Six hours a week, first semester of Senior year.

MINING LAW.

The proper construction of the mining laws of the United States is a subject of great importance not only to the mining engineer, but to all who are interested in the ownership or control of mining property.

The Trustees of the School of Mines have inaugurated a course of lectures on this subject and have secured the services of Judge J. B. Clayberg as lecturer. His Course of lectures will embrace the following topics :

How a mining right may be initiated.

By whom and upon what land.

How it may be continued or lost.

How it may ripen into an absolute title.

What rights may be acquired in cross-veins and veins uniting on the dip.

What rights are acquired under tunnel claims and rights.

What are extra-lateral rights and when do they attach.

Rights of inspection and survey of adjoining mines.

How title is acquired in coal lands.

Mining partnerships.

A general treatment of other subjects especially bearing on the law of mines on the public domain of the United States.

EQUIPMENT

The equipment of the School of Mines has been secured through appropriations made by the legislature of the State. The total sum invested for this purpose now amounts to more than \$35,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The lists that follow represent only a few of the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

MATHEMATICS.—The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of Engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

CHEMISTRY.—In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigating is very great, and the successful prosecution of the purpose for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been devoted to the use of this department, together with a lecture room on the second floor. In this space three laboratories have been fitted up, one each for qualitative and quantitative analysis, and two professors' laboratories.

To these have been added a balance room, a store room of laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast, Bunsen burners, a rack for chemical reagents and a cupboard with lock and key, so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The qualitative and quantitative laboratories are sufficient for the accommodation of 48 students each.

The students' balance room is provided with six analytical balances for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls or floor of the building so that the vibration is reduced to a minimum.

The professors' private laboratories and preparation rooms are equipped with modern conveniences for carrying on analytical work. In these rooms all the chemical reagents are prepared for the use of the students in the other laboratories, and all check analyses on the students' work are made. A dark room is provided for photographic work, spectrum analysis, making blue prints and lantern slides.

The Chemical Lecture room, located on the second floor, is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

METALLURGY.—The assay laboratory is situated on the first or basement floor of the building, and is equipped with six of the latest modeled coal assay furnaces. There are also two gas assay furnaces, which can be used for special work, and a gas retort and melting furnace for melting bullion, making alloys, retorting amalgam, casting copper and other anodes, etc.

The pulp room adjoins the assay laboratory, where all charges are weighed and fluxed. Convenient cupboards are provided for storing samples. The silver and gold balances are located in the same room as the analytical balances, and are of the latest approved design, with agate bearings.

The ore dressing room is provided with a Gates crusher, a Low crusher, an Englebach grinder, capable of grinding pulp to 80 mesh, a buckboard, tables upon which to roll samples, and a series of drawers capable of holding 260 twenty-five pound pulp samples. Our supply of assay samples consist of a large number of copper, lead, gold and silver ores, together with mattes, both copper and lead, slags, flue-dusts, calcines concentrates, tailings and all smelter products from the copper and lead smelters and other plants of the State. Each student is required to collect, crush, grind and buck five twenty-five pound samples in the assay course, and to cut down and assay these samples

In the assay laboratory are located ten separate cyanide outfits for testing 50 to 100-pound lots of ore by the cyanide process. Also a chlorination barrel in which 100-pound lots can be tested by this process. There is also located in this laboratory, a calcining furnace capable of being used as a reverberatory or muffle roasting furnace, where large lots can be simply calcined, or a chlorination roast can be made for the hyposulphite treatment. We have arrangements for treating free milling gold ores by the amalgamation process, as well as cyaniding the tailings from this process.

Gas analysis is at present carried on in the chemical lecture room. We have a very complete set of Hempel's gas apparatus and analyses are made of gases of combustion, reverberatory and blast furnace, and illuminating gases, as well as air, etc.

Students are not permitted to do any work other than that outlined in the regular courses, except under the direction of the professor in charge.

GEOLOGY AND MINERALOGY.—To this department has been assigned:—a large room on the first or main floor as a museum, three rooms on the second floor, viz.: a lecture room, an office and supply room, and a mineralogical laboratory, and four rooms on the third floor. These rooms are designated as the thin section lathe room, the dark room, the storage room, and the petrographic laboratory.

The museum is occupied by models of mining properties in Butte, a large geologically colored topographic model of the United States, and various collections of minerals, rocks and fossils. There are six mine models, namely:

1. Black Rock-Niagara model, constructed by R. G. Brown, for the Niagara Mining Company.

- 2, 3. Colusa Parrot-Never Sweat models, made for the Colusa Parrot Mining Company, one model to show the workings and another to show the economic geology of the mines.

- 4, 5. Colusa Parrot—Never Sweat models, made for the Anaconda Copper Mining Company, (loaned to the school) one being a block model and the other a skeleton model to show the relative direction of the various veins.

6. Colusa Parrot—Never Sweat model, made for the Colusa Parrot Mining Company, showing all the workings to a true scale; to be exhibited at Portland in 1905. This model is accompanied by a map of workings in the Colusa Parrot district made for the Colusa Parrot Mining Company.

The museum is mainly occupied by choice collections of minerals and geological specimens. Amongst these may be enumerated:

- a. Two ton specimen of copper ore exhibited at Omaha in 1898 by the Anaconda Copper Mining Company.

- b. Systematic collection of minerals.

- c. Series of fossils representing all geological horizons.

- d. Collection of rocks illustrating geological phenomena.



INSPECTING A MINE.

- e. Series of ores of economic importance.
- f. Series of fossils from the Tertiary basin of Paris.
- g. Collection of rocks illustrating all petrographic types.

(The last collections are installed in one oak wall case 25 feet long by 7 feet high by 2 feet wide and four plate glass center cases with oak bases, each 10 feet long by $3\frac{1}{2}$ feet high by 2 feet wide.)

- h. Series of 336 thin sections of rocks illustrating all petrographic types.
- k. Oriented thin sections of important rock forming minerals.
- l. Other thin sections of rocks and minerals, about 300 in number.

The lecture room on the second floor is seated for the accommodation of forty students, is provided with large blackboards, and with geological diagrams and maps.

The office and supply room contains:

- a. Library of geology and mineralogy, including complete sets of some important periodicals, all current magazines devoted to these sciences, both American and European, a large number of text books and monographs, and a goodly share of the official geological publications.
- b. Collection of common rocks for class study.
- c. Extensive collection of minerals, classified according to their chief base present, for class use.
- d. Collection of ores of special districts.
- e. Three series of crystal models.
- f. Collection of minerals for blowpipe analysis.
- g. Chemicals and blowpipe apparatus.
- h. Hydraulic blast, hood, oven with automatic temperature regulator, combustion furnace, etc.

The mineralogical laboratory is furnished with :

Six modern blowpipe laboratory tables each 11 feet long by 4 feet wide by 5 feet high, provided with water and gas. The table tops are of plate glass with aluminum rims—each table will accommodate six students at one time:—

Complete apparatus for each student.

An analytical balance, two Jolly balances, three Plattner scales, hydraulic blast hood, Westphal balance, application goniometers, etc.

A collection of minerals to illustrate all their physical characters.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Penfield goniometers for personal use; the department has, further, three sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The elaborate mine models in the museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are oper-

ated by means of an electric motor; each student is expected to learn to make his own thin sections of rocks. At the same time several series of thin sections already prepared, including the series with rock samples arranged to accompany Rosenbusch's classic text, are available for study. The latest model French microscopes are employed for the microscopic studies of rocks and minerals.

All the useful accessories for this work are at hand, including the Bertrand lens, the Fedoroff inclining stage, the Michel Levy comparateur, the Lacroix axial goniometer, and a microphotographic apparatus. In order to permit ready and convenient use of the last a large dark room has been fitted up in the third story; it serves also for goniometric practice and photographic work.

Five additional microscopes have been ordered to accommodate larger classes in this work during the year 1905-06.

PHYSICS.—The Department of Physics occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons, and is provided with modern lecture-room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy tables and apparatus for the measurement of physical constants. Among the measurements that may be made in the domain of mechanics and heat may be mentioned measurements of density, elasticity, the force of gravity, the latent heat of fusion and of evaporation, specific heats, verification of Boyle's law, etc. For the measurements in electricity, galvanometers, resistance boxes with the necessary batteries, keys, etc., are provided.

For the work in light there is provided a spectrometer and an optical bank, together with lenses and attachments for the measurement of focal lengths and for constructing telescopes and microscopes.

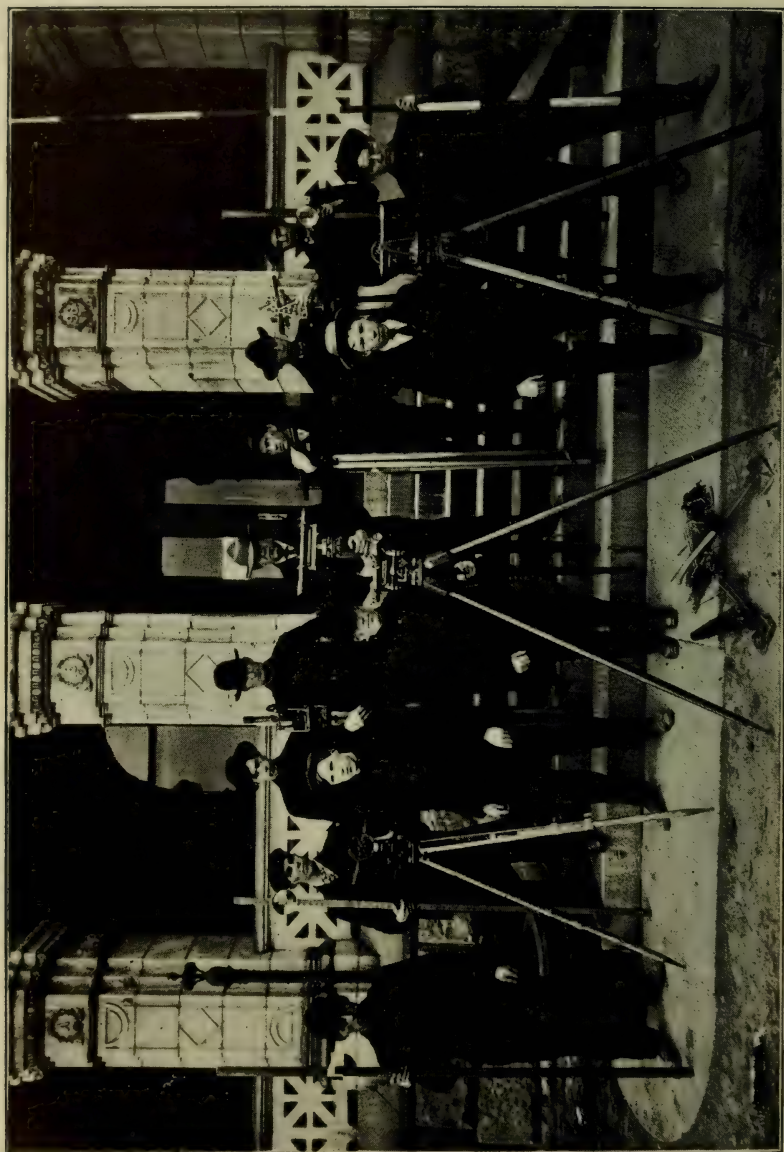
ELECTRICAL APPARATUS.—In the basement of the building a dynamo room is provided with an eleven horse-power gas engine, from which are belted direct and alternating current dynamos. A switchboard connects these machines with lines running to various parts of the building. A storage battery of ten cells is also connected to the switchboard. For the purpose of making measurements there is provided a collection of Weston volt and ammeters for both direct and alternating currents, rheostats, dynamometers, etc. The electrical laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements. In connection with this laboratory there is a small shop equipped with a thirteen-inch screw-cutting lathe and a set of hand tools for wood and metal working.

TESTING LABORATORY—The testing laboratory is equipped with a 100,000-pound Olsen machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Oleson compression micrometer especially designed for measuring the compression of stone cubes and other building materials; one Olsen improved deflection instrument for measuring the deflection of beams subjected to a load; one Henning's improved micrometer instrument for measuring the elongation or compression of long specimens. This instrument measures one ten-thousandth part of an inch, and the point of contact of the screw is an electric contact through which signal is given.

The gas engine is provided with brakes and the necessary measuring instruments for making a complete mechanical test of the engine.

The calibration of instruments, and the heating values of fuels is made a part of the course and the requisite instruments are provided.

MINING ENGINEERING.—A room 32 feet by 108 feet on the third floor is being fitted to serve as an ore dressing laboratory and model room, in which students of the Senior and



CLASS IN SURVEYING.

Junior classes will have an opportunity to make laboratory tests on the mechanical preparation of ores preparatory to subsequent metallurgical treatment. In addition, opportunities will be afforded for the study of the working of mining, ore dressing and hydraulic machines or models of the same.

Drawing Rooms.—The drawing classes occupy one large, well-lighted room, 30 feet by 60 feet, on the third floor and one room, 30 feet by 30 feet, on the second floor. Ample table room and individual drawer room are provided throughout; cabinets for filing drawings and drawing boards are also provided. A large collection of drawings furnished by various manufacturing companies of mining machinery is on hand and used as an aid to the student in developing new work. The collection of parts of machines is gradually increasing. This material is of great assistance to the department in developing the work in machine design.

For the practical work in surveying the following has been provided:—Five engineer's transits; one from Buff and Buff, one from C. L. Berger & Son's, two from Gurley, and one from Keuffel and Esser. Four levels—One from Buff, one from Gurley, one from Keuffel and Esser and one from Berger. One sextant with artificial horizon, from Gurley; two aneroids by Short and Mason (London), and a collection of minor apparatus including Locke levels, chains, tapes, plummets, shaft plumbing equipment, rods and flags, necessary in carrying on the work of the department.

THE LIBRARY.

The library of the School of Mines has been increased during the past year to such an extent that it is necessary to transfer it to more commodious quarters.

Since 1901 the School of Mines has been the depository of the publications of the United States government. By this

means, and through donations from friends of the School, it is now in possession of a large collection of Reports of Geological and other Scientific Surveys, Explorations and investigations made under governmental supervision. Many of the scientific magazines, a list of which follows, are bound, as fast as each volume thereof is completed. These, with the "Daly Collection of Technical Scientific Books," give to those connected with the School a very valuable working library.

THE MARCUS DALY COLLECTION.

This collection of technical scientific books was purchased from a fund of \$300, donated by Mrs. James W. Gerard, of New York City, and is named in honor of her father, the late Marcus Daly. To this has been added other technical works purchased from the surplus of the registration fees of the School of Mines.

MAGAZINES.

The following technical and general magazines and periodicals will be found in the library and in the rooms of the members of the faculty, where they may be freely consulted by the students:

American Geologist.
American Journal of Science.
American Review of Reviews.
Annales de Chimie et de Physique.
Annals of Mathematics.
Berichte d. d. Chemischen Gesellschaft.
Bulletin de la Societe Geologique de France.
Bulletin de la Societe Mineralogique de France.
Bulletin of the Geological Society of America.
Chemical News.
Comptes Rendus.
Electrical World and Engineer.
Electrician.
Engineering—London.
Engineering and Mining Journal.
Engineering Magazine.
Engineering News.

Geological Magazine.
 Indian Engineering.
 Iron and Steel Magazine.
 Journal of American Chemical Society.
 Journal of the Chemical Society of London.
 Journal of Geography.
 Journal of Geology.
 Machinery (Engineering Edition).
 Mathematical Magazine.
 Mineral Industry.
 Mineralogical Magazine.
 Mines and Minerals.
 Mining and Scientific Press.
 Mining Magazine.
 National Geographic Magazine.
 Nature.
 Neues Jahrbuch fur Geologie, Mineralogie, etc.
 Outlook.
 Popular Science Monthly.
 Quarterly Journal of the Geological Society of London.
 School of Mines Quarterly.
 Science.
 Transactions of the American Institute of Mining Engineers.
 Tschermak's Petrographische und Mineralogische Mittheilungen.
 Zeitschrift fur Krystallographie.
 Zeitschrift fur Praktische Geologie.

The following newspapers are kindly furnished by their publishers free of charge :

The Ravalli Democrat (weekly), Hamilton.
 Great Falls Leader (daily), Great Falls.
 The Missoulian (daily), Missoula.
 Blue Mountain American (weekly), Baker City, Oregon.
 The Tribune-Review (weekly), Butte.
 The Evening News (daily), Butte.

DONATIONS TO THE LIBRARY.

Valuable gifts of books, reports and pamphlets have been received from :

Wm. Anderson, Govt. Geologist.....Pietermaritzburg, Natal, S. Africa
 Lewis C. Aubury, State Mineralogist Sacramento, Calif.
 Robert Bell, Director Geological Survey Ottawa, Canada
 A. E. Birge, Director Geological Survey.....Madison, Wis.
 W. S. Blatchley, State Geologist Indianapolis, Ind.
 H. Y. L. Brown, Govt. Geologist Adelaide, So. Australia

E. R. Buckley, State Geologist	Rolla, Mo.
Richard Butler, Minister for Mines	Adelaide, So. Australia
John Byrne State Inspector of Mines	Helena Mont.
Samuel Calvin State Geologist	Iowa City, Iowa
Wm. B. Clark, State Geologist	Baltimore, Md.
Oscar J. Craig, President State University	Missoula, Mont.
J. W. Crockett, Secretary of State	Little Rock, Ark.
Melville Dewey, State Librarian	Albany, N. Y.
J. A. Ferguson, Commissioner Agric., Labor & Indus.	Helena Mont.
J. W. Gregory, Director Geological Survey	Melbourne, Victoria
H. Gregory, Minister for Mines	Perth, West Australia
Erasmus Haworth, State Geologist	Lawrence, Kans.
G. Henriksen, Govt. Inspector of Mines	Christina, Norway
Mrs. Laura E. Howey, Sec. Historical Society	Helena, Mont.
Henry B. Kummel, State Geologist	Trenton, N. J.
Alfred C. Lane, State Geologist	Lansing, Mich.
A. Liversidge, Sec. Austral. Assoc. Adv. Sci.	Sydney, N. S. Wales
A. Gibb Maitland, Govt. Geologist	Perth, West. Australia
Richard McBride, Minister for Mines	Victoria, B. C.
James McGowan, Minister for Mines	Wellington, N. Zealand
D. McLeod, Minister of Mines	Melbourne, Victoria
John X. Merriman, Chairman of Committee, Geol. Survey.....	
.....	Cape Town, S. Africa
A. Michael-Levy, Director Geological Survey	Paris, France
J. Obalski, Inspector of Mines	Quebec, Canada
Edward Orton, Jr., State Geologist	Columbus, O.
Geo. H. Perkins, State Geologist	Burlington, Vt.
Jas. Reid, Pres. Mont. Agr. College	Bozeman, Mont.
John P. Schmidt, Register of Land Office	Helena, Mont.
F. J. V. Skiff, Director Field Columbian Museum	Chicago, Ill.
Eugene A. Smith, State Geologist	University, Ala.
H. H. Swain, Pres. State Normal School	Dillon, Mont.
J. J. H. Teall, Director Geological Survey	London, England
W. H. Twelvetrees, Govt. Geologist	Hobart, Tasmania
John S. Wade, State Engineer	Helena, Mont.
W. H. Wallace, Secretary of Mines	Hobart, Tasmania
I. C. White, State Geologist	Morgantown, W. Virginia
James White, Geographer	Ottawa, Canada
W. S. Yeates, State Geologist	Atlanta, Georgia

DONATIONS TO THE DEPARTMENT OF GEOLOGY AND MINERALOGY.

- F. W. Bacorn, Butte, Montana.—Samples of free gold ore from the Cable mine, Deer Lodge Co., Montana.
- Thos. Bryant, Butte, Montana.—Samples of hubnerite and pseudomorphs of Chalcocite and chalcopyrite after enargite from the Original and Stewart mines, Butte, Montana.

- T. W. Buzzo, Butte, Montana.—Samples of ore from the Alice mine, Butte.
- Thos. G. Haydn, Kendall, Montana.—A fossil teleost fish from the Cretaceous, near Green River, Wyoming.
- A. J. Huneke, Butte, Montana.—Native copper nugget from the Copper River region, Alaska.
- C. W. Randall, Bozeman, Montana.—Samples of corundum crystals and ore from land of Bozeman Corundum Co., Gallatin Co., Montana.
- J. P. Reins, Butte, Montana.—Samples of copper ore from the Combination mine, Butte, Montana.
- J. R. Thompson, Butte, Montana.—Samples of chalcotrichite from the Shannon mine, Clifton, Arizona.
- G. W. Tower, Butte, Montana.—Covellite and copper stalacite from a mine in sandstone in the La Salle Mts., Colorado.
- H. V. Winchell, Butte, Montana.—Gold ore and porphyry from Goldfields and Tonopah, Nevada.
- W. F. Word, Helena, Montana.—Sample of charcoal gold ore and of phonolite, and three photographs of Thunder Mt. district, Idaho.
-

DONATIONS TO DEPARTMENT OF MINING ENGINEERING.

- Pelton Water Wheel Co., San Francisco.—One 12-inch Standard Motor.
- The Ben Cyrus Co., South Milwaukee.—Blue prints of steam shovel and dredge.
- Knowles Steam Pump Works, New York.—Blue prints of steam pumps.
- Fred. M. Prescott Steam Pump Co., Milwaukee.—Blue prints and description of steam pumps.
- Keuffel & Esser Co., New York.—Model of slide rules.
- A. W. Faber Co.—Model of slide rules.
-

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions are made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense

to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter; the opportunity is here presented for daily observation of works whose development and whose product have given to the city of Butte the reputation of being the greatest mining center in the world.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them, but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place, permission is given to the mining classes to witness the same, under the guidance of their instructors.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

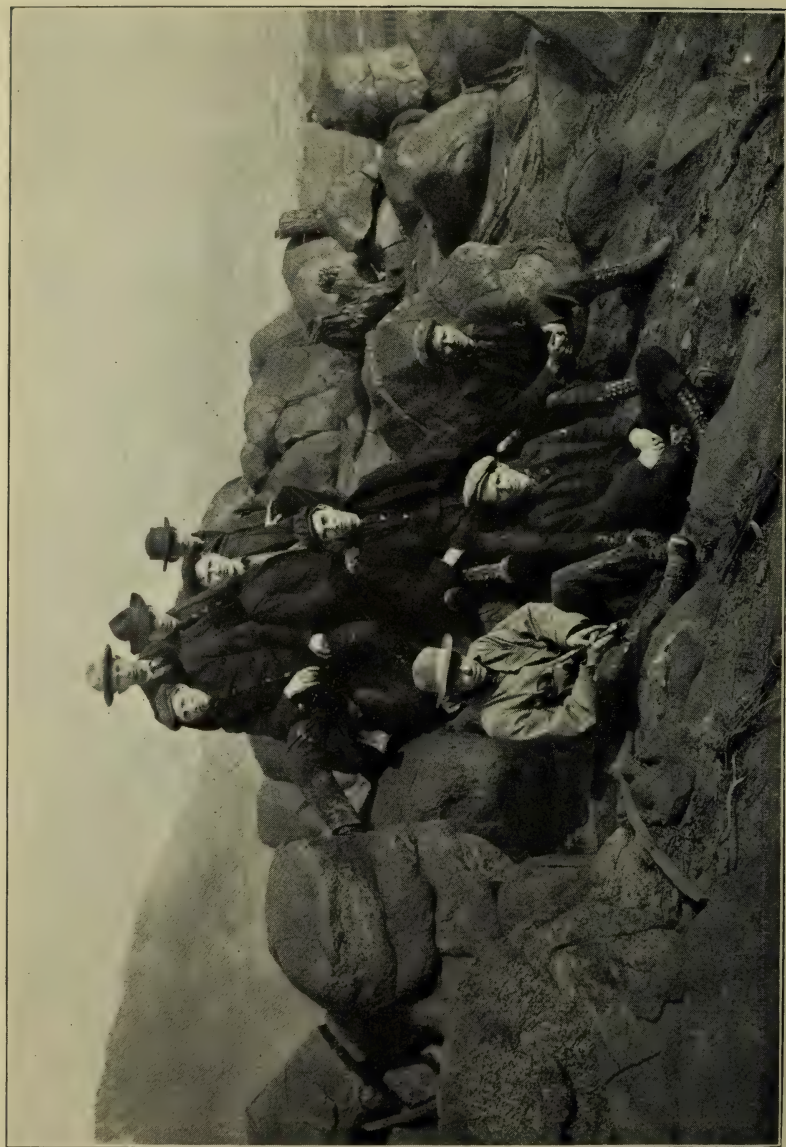
Besides these comparatively short excursions, six weeks of field practice in surveying and mining engineering are required at the close of the Freshman and again at the close of the Junior year. During these periods the entire time of the student is given to acquiring, under the direction of the professor in charge, a familiarity with the use and adjustment of engineering instruments and with the best methods of solving the problems that address themselves to the engineer.

EXCURSIONS OF 1904-5.

The following is a list of the formal excursions that have been made during the year 1904-5 :

METALLURGICAL EXCURSIONS

SENIOR CLASS.—Excursion to East Helena Lead smelter, East Helena, Montana, and U. S. Assay Office, Helena, October 5th to 8th, 1904.



ON A GEOLOGICAL TRIP.

SENIOR CLASS.—Excursion to cyanide plants of Barnes-King Co., and Kendall Mining Co., Kendall, Montana; to the Gilt Edge Mining Co., at Gilt Edge, Montana; to the Big Six Mining Co., Whiskey Gulch, Montana; to amalgamation plant and mill of Big Indian Mining Co., near Helena, Montana, and to the B. & M. copper smelter, at Great Falls, Montana, December 6th to December 22d, 1904.

JUNIOR CLASS.—Metallurgical trip to the B. & M. copper smelter, at Great Falls, Montana, January 16th to January 21st, 1905. To Washoe Smelter, Anaconda, Montana, with Junior class, January 28th, 1905.

JUNIOR CLASS.—Metallurgical trip to cyanide plants and smelters at Deadwood, South Dakota, May 19th to June 3d, 1905.

GEOLOGICAL EXCURSIONS—JUNIOR CLASS.

To the Alice mine, February 10th, 1905.

To the Original mine, February 17th, 1905.

To the Leonard and East Colusa mines, Feb. 24th, 1905.

To the Mountain View mine, March 3rd, 1905.

To the Mountain View mine, March 10th, 1905.

To the Black Rock mine, March 24th, 1905.

To the Combination mine, Mar. 31st, 1905.

To the Goldsmith mine, April 5th, 1905.

To the Gagnon mine, April 7th, 1905.

MINING EXCURSIONS.

June 14 to July 22, 1904.—Senior Class to Coeur d'Alene district, in Idaho. Mine surveying and mining.

July 26 to September 2, 1904.—Sophomore Class, to Lake Pend d'Oreille, near Hope, Idaho. Field work in surveying.

December 6 to 20, 1904.—Junior Class, to Barnes-King, Kendall and Gold Reef mines, Fergus county, Montana.

March 30, 1905.—Junior Class, to Butte Reduction Works and Concentrator, Butte, Montana.

April 11, 1905.—Junior Class, to Basin Reduction Co.'s Concentrator, Basin, Montana.

May 18 to June 1, 1905.—Junior Class, to mines at Deadwood, South Dakota.

EXPENSES

FEES.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.—To secure the State against loss for apparatus that may be broken by the student, a deposit is required of each one, engaged in laboratory work, at the opening of the year. This deposit is placed in the hands of the Treasurer of the Board of Trustees. Each student is charged with the apparatus issued to him. At the close of the year he is credited with such articles as he returns in good order. The balance of this account is then returned to him.

The following is the list of deposits that are required:

FRESHMAN YEAR.

General Chemistry and Qualitative Analysis	\$15.00
Surveying	10.00

SOPHOMORE YEAR.

Quantitative Analysis	\$15.00
Mineralogy	10.00

JUNIOR YEAR.

Metallurgy and Assaying	\$10.00
Mine Surveying	10.00

SENIOR YEAR.

Petrography	\$10.00
Metallurgy	10.00

When the breakage exceeds the deposit the student will be required to make good the full amount of the damage done.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the city of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. Those who find it necessary to economize can avail themselves of opportunities for doing so similar to those they could find elsewhere.

GENERAL INFORMATION

The City of Butte is widely known, as the great mining center of the country. A little more than forty years ago this region began to attract attention because of the rich gold placers that had been found within and near to the limits of the present City of Butte. These proved to be very rich. No reliable statistics are at hand showing their actual yield. It is commonly stated that the total yield of the placer mines of Montana during the twenty-five years from 1863 to 1888 was not less than \$200,000,000. It is doubtless true that the Butte placers contributed a fair proportion of the grand total.

When the placers began to show signs of exhaustion the sturdy miners began to search for the "Mother Lode," or source from which the gold of the placers had been derived. In this search, such mines as the Alice, the Moulton, Lexington, Anaconda and other rich ledges were discovered. These mines were first worked as silver, or silver-gold properties. As the explorations were carried to lower depths the ore often became so rich in copper, that the more precious metals came to be considered as a minor or by-product, and the camp began its more important career as a producer of copper. While lead, zinc, gold and silver are produced to the value of probably \$15,000,000 per year, it is to the immense yield of the red metal that the city is indebted for its prominence as a mining center.

The magnitude of the copper product of this city may be seen by the following official figures for the year 1903:

COPPER PRODUCTION FOR 1903.

Total production of the world	585,081 long tons.
Montana's production	121,677 long tons

As more than 99 per cent of Montana's product comes from Butte, it will be seen that one-fifth of the world's output of copper comes out of the mines of the City of Butte.

The extraction and treatment of the immense mass of ore, from which this great product has been obtained has called for the employment of the best talent and the largest resources. In our mines and reduction works no expense has been spared to provide in all ways for the best and most economical means of securing desired ends. The mines themselves, the smelters and reduction works of this city and of the nearby towns and cities where Butte's ores are treated, are one great system of workshops and laboratories, great, complete and efficient, beyond comparison with those that could be found in connection with any mining or technical school.

The location of the Montana State School of Mines in this city means, that its pupils will be brought into constant contact with men who are personally engaged in mining and thoroughly conversant with all the practical details of their work. It means that the student will have almost daily opportunity to witness some phase of the most successful methods used in the various departments of practical mining. It means that the vast installment of mining and metallurgical plants here is in some real sense a part of the equipment of the School of Mines.

The attitude of the great mining companies, and of the lesser companies, and individual mine owners, as well, toward the School of Mines, has always been most friendly and helpful, and all proper opportunity is freely given to visit and to observe the operations conducted in their various plants.

CATALOGUE OF STUDENTS, 1904-5.**SENIOR CLASS.**

Archibald, George	Butte, Montana
Brinton, Owen F.	Butte, Montana
Corey, Clarence R.	Ansonia, Conn.
Duthie, John M., Jr.	El Paso, Texas
Elford, Basil E.	Anaconda, Montana
Mackel, Louis C.	Ada, Minnesota
Pratt, Paul D.	Libby, Montana
Stevenson, Leon R.	Alamo, Oregon
VanGundy, Jay E.	Deer Lodge, Montana

JUNIOR CLASS.

Dugan, John F.	Butte, Montana
Feeney, Charles W.	Butte, Montana
Gieser, Herbert S.	Butte, Montana
Johns, John W.	Butte, Montana
Kane, Louis M.	Butte, Montana
Warfield, Herschel J.	Butte, Montana
Wilson, T. Bert	Butte, Montana
Young, Siegfried A.	Astoria, Oregon
Young, Arthur B.	Astoria, Oregon

SOPHOMORE CLASS.

Adami, Arthur E.	Helena, Montana
Bovett, Clifford A.	Butte, Montana
Brinton, Charles C.	Butte, Montana
Clingan, Huett S.	Belt, Montana
McCrackin, Ralston H.	Butte, Montana
Meiklejohn, Archie B.	Butte, Montana
Reardon, Daniel	Butte, Montana
Shaffer, Wm. A.	Glenn Falls, N. Y.
Villars, Jesse R.	Arkansas City, Kansas

FRESHMAN CLASS.

Baker, Jacob H.	Butte, Montana
Bowden, Malcolm	Helena, Montana
Brulo, William	Helena, Montana
Corr, Frank R.	Butte, Montana
Ellis, Willis	Butte, Montana
Foote, Frank A.	Butte, Montana
Glass, Frank A.	Helena, Montana
Hammer, Fred. L.	Helena, Montana
Harlan, Clyde C.	Kansas City, Mo.
Heimerdinger, Harry B.	Butte, Montana
Hoffman, David A.	Great Falls, Montana
Harris, Francis C.	Butte, Montana
Ketcham, S. H.	Clinton, Montana
Kyle, Robert G.	Butte, Montana
Lomas, Percy	Butte, Montana
Lowry, Thomas M.	Butte, Montana
McLaughlin, W. D.	Butte, Montana
Morton, Claude H.	B. S. Western Coll., Ia., Toledo, Iowa
O'Brien Bert	Butte, Montana
Pigott, M. Curtis	Helena, Montana
Powers, Simon C.	Lynchburg, N. Dakota
Proctor, Israel O.	Great Falls, Montana
Proctor, Merton D.	Great Falls, Montana
Walton, Lee M.	Butte, Montana
Williams, Daniel J.	Kalispell, Montana

PREPARATORY CLASS.

Brasier, Walter G.	Butte, Montana
Haines, Peter	Butte, Montana
Loughran, Michael	Butte, Montana
Scott, Percival	Livingston, Montana

SPECIAL COURSES.

Bard, Dorsey C.	Butte, Montana
E. M. Harvard U. Subject, Petrography.	
Cornelius, Ben. J.	Butte, Montana
Subject, Qual. and Quant. Analysis.	
Kirby, Kenneth F.	Butte, Montana
Subject, Assaying and Metallurgy.	
Farnham, Leroy S.	Butte, Montana
Subject, Quant. Analysis.	
Lippett, Chester B.	Duluth, Minn.
B. S. Carleton Coll. Subject, Mining and Metallurgy.	

SUMMARY.

Seniors	9
Juniors	9
Sophomores	9
Freshmen	25
Preparatory	4
Special	5
	—
Total	61

REGISTER OF THE ALUMNI BY CLASSES

1903.

Louis V. Bender 404 E. 3rd St., Anaconda, Montana
Chemist, Anaconda C. M. Co.

1904.

Alfred J. Balmforth 505 West Galena St., Butte, Mont.
West Stewart Mine.

Clara Clark 201 N. Jackson St., Butte, Mont.

J. Fred. Duling 235 W. Copper St., Butte, Mont.
With Harper & MacDonald, Engineers.

Arthur L. Irelan Helena, Montana
Mining Engineer.

Henry E. Kuphal Virginia City, Montana
Mining Engineer, Alder Co.

Isabel Little 1712 N. Calvert St., Baltimore, Md.

Lachlan D. McRae Zortman, Montana
Mining Engineer, Alder Gulch Mining Co.

John McGee Kendall, Montana
Mining Engineer, Barnes-King Mining Co.

P. L. Pauly Butte, Montana
Draughtsman for J. G. Link, Architect.

H. S. Tallant 832 W. Park St., Butte, Montana
Sampler and Time Keeper, East Colusa Mine.

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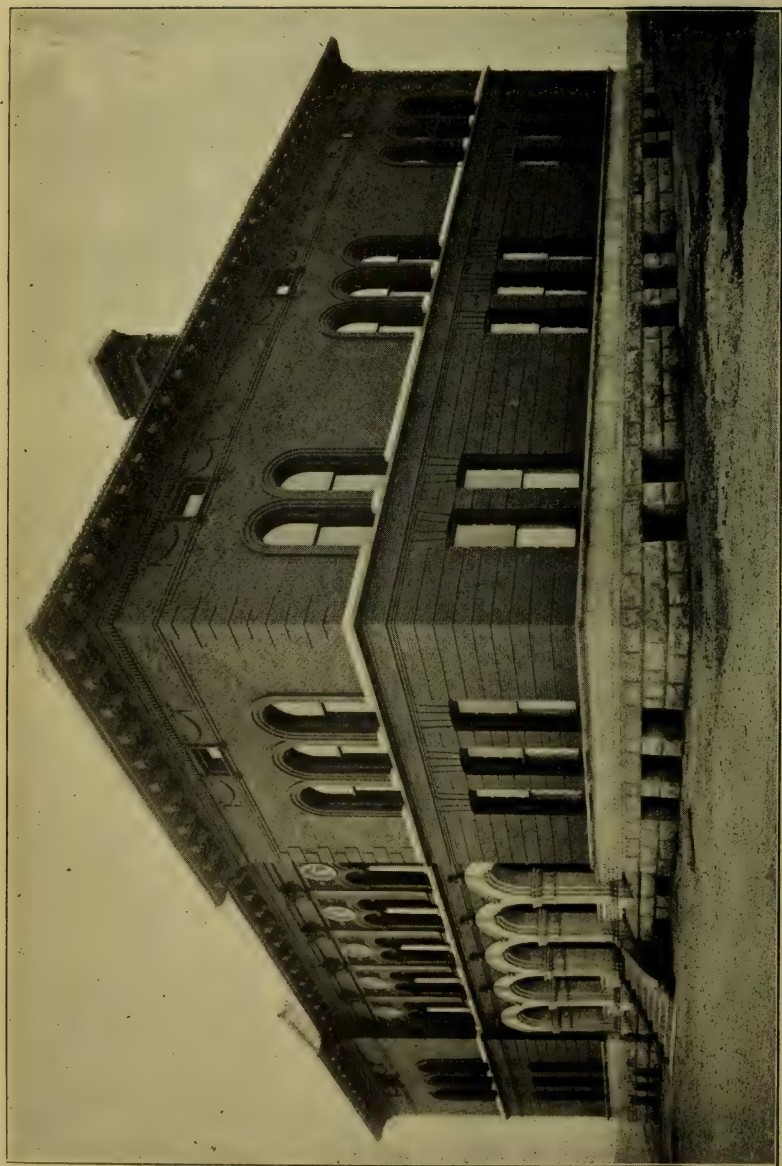
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MONTANA STATE SCHOOL OF MINES



SIXTH ANNUAL CATALOGUE
1905 - 1906

BUTTE, MONTANA

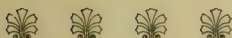


SCHOOL OF MINES BUILDING.

Montana

State School of Mines

Butte



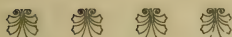
SIXTH ANNUAL CATALOGUE OF

OFFICERS AND STUDENTS

FOR THE YEAR 1905-1906

WITH ANNOUNCEMENTS FOR THE YEAR

1906-1907



BUTTE, MONTANA

Calendar for 1906-7

1906.

September 7 and 8—Entrance Examinations.

Special Examinations for Conditioned Students.

September 10—First Semester Begins.

November 27—Thanksgiving—Holiday.

December 21—Holiday Recess to January 7, 1907.

1907.

January 31—Term Examinations Begin.

February 1—End of First Semester.

February 4—Second Semester Begins.

February 22—Washington's Birthday—Holiday.

May 30—Decoration Day—Holiday.

May 31—Final Examinations of Senior Class.

June 4—Term Examinations Begin.

June 7—Commencement Day.

June 11—Junior Field Work in Mining Engineering Begins.

July 23—Sophomore Field Work Begins.

July 22—Junior Field Work in Geology.

1907-8.

September 9—First Semester Begins.

CALENDAR FOR THE COLLEGE YEAR 1906-7

[illegible]

BOARDS OF CONTROL

STATE BOARD OF EDUCATION

(Ex-Officio.)

JOSEPH K. TOOLE, *Governor of the State*

ALBERT J. GALEN, *Attorney General.*

W. E. HARMON, *Sup't Public Instruction.*

(Appointed.)

JOHN M. EVANS Missoula
(Term Expires February 1, 1910.)

N. W. McCONNELL Helena
(Term Expires February 1, 1907.)

E. O. BUSENBERG Lewistown
(Term Expires February 1, 1907.)

S. D. LARGENT Great Falls
(Term Expires February 1, 1908.)

O. P. CHISHOLM Bozeman
(Term Expires February 1, 1908.)

G. T. PAUL Dillon
(Term Expires February 1, 1909.)

C. N. KESSLER Helena
(Term Expires March 2, 1909.)

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W. E. HARMON	Secretary

COMMITTEE ON SCHOOL OF MINES.

E. O. BUSENBERG.

G. T. PAUL.

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(Term Expires January 1, 1910.)	
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(Term Expires January 1, 1908.)	
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NATHAN R. LEONARD, A. M.,
President and Professor of Mathematics.

ALEXANDER N. WINCHELL, Doctor Univ. Paris,
Professor of Geology and Mineralogy.

CHARLES H. BOWMAN, M. S.
Professor of Mechanics and Secretary of the Faculty.

ERWIN H. MACDONALD, E. M.
Professor of Mining Engineering.

WILLIAM G. KING, A. M.
Professor of Chemistry and Metallurgy.

JOHN B. CLAYBERG, L. L. B.,
Lecturer on Mining Law.

LESTER J. HARTZELL, E. M.
Assistant Professor of Chemistry.

GEORGE W. CRAVEN, B. S.
Assistant Professor in Mining Engineering.

JOHN S. SCHMIDT
Assistant in Chemistry.

PETER L. PAULY,
Assistant in Mineralogy.

JOSEPH ROBERT,
Janitor.

Montana State School of Mines

HISTORICAL SKETCH.

The "Enabling Act," which paved the way for the admission of the territories of Dakota, Montana and Washington into the Union as States, contained a provision for a donation of public lands to each for the "establishment and maintenance of a State School of Mines." The grant to Montana was one hundred thousand acres, and the minimum price at which it was permitted to be sold was ten dollars per acre, thus insuring ultimately a fund of one million dollars for this purpose.

The date of this act was February 22nd, 1889. It was a significant date, and it marks the first plain national provision for education in the interest of the Mining Industry. This legislation was the natural and almost necessary sequel to the Morrill Act of 1862, which provided for the establishment and maintenance of State Colleges for education in Agriculture and the Mechanical Arts.

Mining and agriculture stand preeminent as factors in the development of the resources of the country and the growth of the nation in wealth and power. It was an enlightened statesmanship that dictated these two systems of education as the best means to secure the best interests of the entire people.

The first Legislative Assembly of the State of Montana appointed Commissioners to select these lands. The last report of the Register of the State Land Office gives the following epitome of the condition of this Land Grant:

Lands selected 99,738.08 Acres

Lands approved 99,211.38 Acres

Lands sold 1,656.16 Acres

This leaves 261.92 acres yet to be selected.

These lands are mainly located in the northwest quarter of the State, and for this reason are not yet saleable at the minimum price fixed by Congress, but the prospective increase of immigration following the development of the many and extensive systems of irrigation planned for our State will soon place some of these lands above the minimum value.

The unsold lands are thus classified in the Register's Report:

Grazing lands	68,428.52 Acres
Timber lands	28,693.16 Acres
Agricultural lands	960.00 Acres

The amount of saw timber on the timber lands has lately been estimated at 120,430,000 feet. This alone can not be valued at less than a quarter of a million dollars.

LOCATION AND ORGANIZATION.

The legislature chose the City of Butte as the location for the State School of Mines. Certain public spirited citizens of Butte donated a plat of ground 376 feet by 500 feet as a building site for the School. This plat is within the present limits of the city and is situated on the southern bench of "Big Butte." It commands a fine view of the city and of the great continental divide, which bounds the horizon on the east, south and west.

The first steps toward the organization of the School were taken by the Legislative Assembly in 1895, when a Building Commission was appointed and authorized to issue bonds to secure funds for the erection of a School of Mines Building. These Bonds were not issued till the summer of 1900, but the building was erected in 1896-7; the funds needed for the purpose were advanced by citizens of Butte, and were replaced later from the proceeds of the Bonds.

The issue of bonds was \$120,000, bearing 5 per cent interest and maturing in thirty years, but payable at the option of the State in fifteen years. The lands of the School and all monies derived from the sale or lease of the same were pledged for the payment of the principal and interest of the bonds. For this purpose these monies have been kept by the State Treasurer in what is known as "The School of Mines Building, Interest and Sinking Fund," and any surplus thereof, above \$2,500, is required to be placed at interest for the benefit of the Fund. The amount in this fund, March 31st, 1906, was \$30,435.79.

A few months since the Attorney General of the State raised the question of the validity of these bonds. In a suit brought in the Supreme Court of the State, it was decided that they were not valid, on the ground that it was the condition of the Land grant that it, or the proceeds thereof, should be kept as a permanent fund, the income of which should be used for the maintenance of the School. An appeal from this decision was taken to the United States Courts, this appeal is still pending. If the Federal Courts sustain the ruling of our Supreme Court, the so-called "School of Mines Building, Interest and Sinking Fund," together with all future proceeds arising in any way from the Land Grant, will be held as a permanent fund, the income of which will be used for the maintenance of the School.

The School of Mines building is of brick, with stone foundation and trimmings. It is four stories high, including the basement. It fronts toward the city and its dimensions are 94 by 118 feet. It contains approximately 37,000 square feet of available floor space and is as nearly fireproof as it was convenient to make it.

The equipment and maintenance of the School is provided by the State through biennial appropriations made by

the Legislative Assembly. The sum provided by the Assembly of 1905 was \$28,750 per year for the fiscal period ending November 30th, 1906.

A plan of organization was adopted by the Board of Trustees in the summer of 1900. It set forth:

That the aim and scope of the School of Mines was determined by Sections 1570 and 1577 of the Political Code of Montana, and that the evident intention of the law was that this institution was designed solely for the purpose mentioned in those sections and not to duplicate unnecessarily any part of the educational work of other State Institutions.

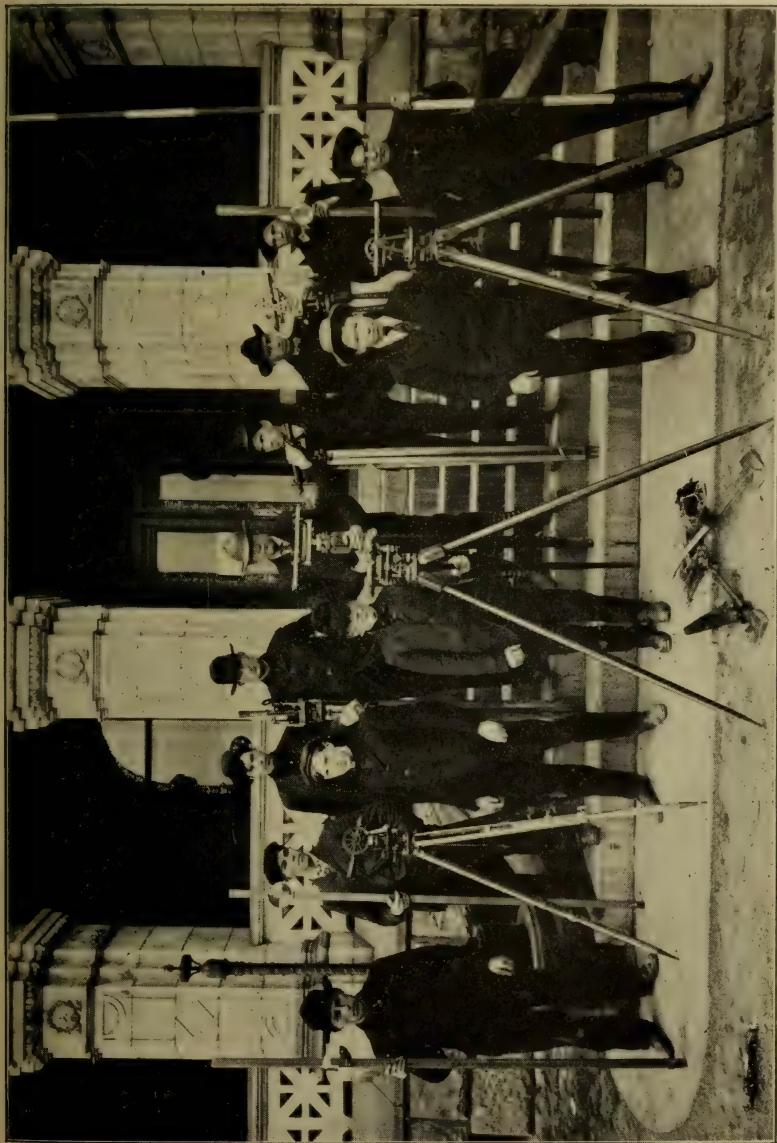
It established a course of study which was modeled to some extent after that which had for some years been in successful operation at the Colorado School of Mines, but in consideration of the unsurpassed facilities offered by the City of Butte for the practical observation of various processes in mining and metallurgy, it was determined that the methods of instruction here employed should be such as to familiarize the students with the practical work along these lines.

The Montana State School of Mines was opened for the reception of pupils on September 11, 1900. A Preparatory Department was added in January, 1901, and continued to the close of the year 1904-5.

This Department was created to meet a temporary want, which, owing to the gratifying increase in the number and efficiency of the High Schools of the State, no longer exists.

BOARDS OF CONTROL.

The control of the entire public school system of the State is by the Constitution vested in the State Board of Education. This Board consists of the Governor of the



CLASS IN SURVEYING.

State, the Attorney General, and the State Superintendent of Public Instruction, together with eight members who are appointed by the Governor and confirmed by the Senate. These last hold office for four years.

In the case of the School of Mines, the Legislative Act establishing the School provided for a Board of Trustees to be chosen by the Board of Education. To the Trustees is committed the immediate supervision of the School, the adoption of a Course of Study and the election of officers and members of the Faculty, but all of the acts of this body are subject to the approval of the Board of Education. The Trustees hold their office for the term of four years.

CONDITIONS OF ADMISSION

The School of Mines is open on equal conditions to all residents of Montana without regard to sex or race, and to the youth of other states and countries, on terms that have been prescribed by the Board of Trustees.

Applicants for admission to the Freshman Class must be seventeen years of age, and must sustain a satisfactory examination in arithmetic, including the metric system, higher algebra through the first twenty-three chapters in Wentworth's Higher Algebra (or an equivalent), plane, solid and spherical geometry, geography, elementary zoology or physiology, physical geography and English composition.

Graduates from the accredited High Schools of the State will be admitted without examination, on presentation of their diplomas; *Provided*, the course of study pursued includes the above topics required for admission to the Montana State School of Mines.

LIST OF ACCREDITED HIGH SCHOOLS.

County High Schools:—

Beaverhead
Broadwater
Carbon
Custer
Fergus
Flathead
Gallatin
Granite
Jefferson
Park
Powell
Sweet Grass
Teton

City High Schools:—

Anaconda
Billings
Butte
Forsythe
Fort Benton
Glendive
Great Falls
Hamilton
Helena
Missoula
Virginia City

Graduates of the Stevensville Training School and graduates of accepted High Schools in other States will be accepted on the same terms as those from the accepted High Schools of Montana.

In all cases, graduates of such schools, whether from this or other States, should present with their diploma the course of study from which they graduated with a certificate from the principal of the school as to the course of study pursued.

It is the opinion of the faculty of the State School of Mines that candidates for admission to this school should at least have taken the full four years course required in an accredited High School, or an equivalent course in some other school.

Candidates for advanced standing will be examined in all the studies of their course preceding those of the class they desire to enter. Credit will be given for work done in other reputable institutions, but the faculty reserves the right,

at its discretion, to examine any applicant notwithstanding he may have such credits.

Persons of mature years and practical experience in mining or metallurgy, who are not candidates for a degree, may be admitted without examination to any of the studies of the course they may be able to pursue with profit to themselves and without embarrassment to the class.

COURSE OF STUDY AND DEGREES

The course of study as outlined on the following pages covers four years and embraces those branches which are considered most important to the mining engineer. Those who complete the course will receive the Degree of Engineer of Mines.

COURSE OF STUDY.

Freshman Year.

FIRST SEMESTER—	Hours per Week
Higher Algebra.....	5
Trigonometry, Plain and Spherical.....	4
General Chemistry.....	3
Laboratory	6
English	3
Mechanical Drawing.....	9

SECOND SEMESTER—

Analytical Geometry.....	5
General Chemistry.....	2
Qualitative Analysis—	
Lecture	1
Laboratory	9
English	3
Surveying	4
Mechanical Drawing.....	6
Surveying, Summer Course of six weeks.	

Sophomore Year.

FIRST SEMESTER—

Hours per Week

Differential Calculus.....	5
Physics	5
Chemistry, Quantative Analysis—	
Lecture	1
Laboratory	12
Crystallography and Physical Mineralogy..	4
Blowpipe Methods.....	3

SECOND SEMESTER—

Integral Calculus.....	4
Physics, Lectures and Laboratory.....	6
Chemistry, Quantitative Analysis—	
Laboratory	6
Descriptive Mineralogy.....	2
Determinative Mineralogy.....	6
Topographical Drawing.....	6

Junior Year.

FIRST SEMESTER	Hours per Week
Mechanics, Analytical and Applied.....	5
Geology, Physical and Historical.....	5
Metallurgy—Assaying for 1st 10 weeks...	9
Technical Gas Analysis and Laboratory Work for 8 weeks.....	3
Lectures and Recitations in Metallurgy of Copper	3
Metallurgical Excursion to Copper Smelt- ers—weeks	2
Testing Laboratory.....	3
Machine Design.....	3
Machine Design, Additional for 8 weeks..	6

SECOND SEMESTER—	Hours per Week
Hydraulics	3
Mechanics of Materials.....	3
Mining	3
Mining Excursions—weeks.....	2
Mine Surveying, Lectures and Recitations..	3
Metallurgy—	
Metallurgy of Gold and Silver.....	3
Laboratory; Cyaniding, Chlorination, Roasting Ores.....	3
Metallurgical Excursion to Cyanide Plants—weeks	2
Geology, Economic.....	3
Geological Excursions.....	3
Drawing, Design and Construction.....	6

Practical Mine Surveying and Mining, Summer Course
of six weeks.

Field Geology, Summer Course of four weeks.

Senior Year.

FIRST SEMESTER Hours per Week

Mechanical Engineering of Power Plants..	3
Graphical Statics.....	3
Mining (9 weeks).....	3
Ore Dressing (9 weeks)	3
Metallurgy—	
Lectures and Recitations in Metallurgy of	
Lead	3
Laboratory	3
Excursions to Lead Smelters—week...	1
Mining Engineering Design.....	6
Petrography—	
Recitations and Lectures.....	2
Laboratory	6

SECOND SEMESTER—

Hours per Week

Mining Engineering.....	5
Ore Dressing Laboratory.....	3
Metallurgy of Iron, Zinc, etc., Lectures and	
Recitations	3
Metallurgical Laboratory.....	3
Power Transmission.....	3
One of the following Electives is required:	
Petrography	9
Metallurgical Design.....	9

DETAILS OF COURSE OF INSTRUCTION

FRESHMAN ENGLISH.

ENGLISH.—Rhetoric and composition—Hill's Principles of Rhetoric is used as a text. The writing of many themes and the reading of several works of standard fiction will be required. The aim of the course is two fold: First, to correct many of the prevalent faults found in the composition of students of this class, and second, to lay the foundation for an easy style of composition. Required of all freshman three times per week through both semesters.

MATHEMATICS.

FRESHMAN YEAR.

ALGEBRA.—Indeterminate Coefficients, Theory and use of Logarithms, Limits, Introduction to Derivatives, Binomial and Logarithmic Series, Tests of Convergency of Series, General Theory of Equations, Solution of Numerical Equations. Textbook, Wentworth's Higher Algebra. *First Semester, Daily Recitations.*

PLANE TRIGONOMETRY.—Goniometry, Solutions of Right and Oblique Angled Triangles, Practical Problems, Construction of Trigonometrical Tables, DeMoivre's Theorem, Expansion of Sine and Cosine in an infinite series.

SPHERICAL TRIGONOMETRY.—Solution of Right and Oblique Triangles, Napiers Circular Parts and Analogies, Applications of Spherical Trigonometry.

Text-book.—Wentworth's Plane and Spherical Trigonometry. *Four recitations per week during First Semester.*

ANALYTICAL GEOMETRY.—The point and straight line, in a plane. Different Systems of Coordinates. The Conic Sections. Discussion of General Equations of the second degree with two variables. Higher Plane curves. The point and straight line in space. Curved Surfaces and surfaces of revolution. Quantics. *Daily Recitations during the Second Semester.*

SOPHOMORE YEAR.

DIFFERENTIAL CALCULUS.—Discussion of the method by limits and infinitesimals. Derivatives of functions. Successive differentiation. Maxima and Minima of functions. Curvature, Involutives, Evolutives and Envelopes. Asymptotes. Singular points and tracing of curves.

Daily recitations or lectures during First Semester.

INTEGRAL CALCULUS.—General and definite integrals of differential functions. Rectification of curves and quadrature of surfaces. Differential equations. Preparation of a table of Integrals. *Four lectures and recitations per week through the Second Semester.*

CHEMISTRY.

GENERAL CHEMISTRY.—The subject of general chemistry is taught by means of a series of experimental lectures given twice a week through the first semester and once a week through the second semester. The course covers rather completely the subject of inorganic chemistry, the student being required to take such notes as will enable him to explain in the class room the principles involved and illustrated on the lecture table. The student is expected to read, in connection with the lectures, standard works on general chemistry. The

lectures are supplemented by text-book work and recitations, extending through the entire year, using a standard work on inorganic chemistry.

Experimental laboratory work is required of each student at his desk, embracing the performance of a selected list of about 75 experiments covering the subject of inorganic chemistry, which must be completed previous to the Christmas vacation. In this laboratory work, the student is taught the manipulation of apparatus, the characteristics of the various acids, bases and salts, and their reactions with each other. This is the foundation upon which his general knowledge of chemistry is based and he is required to keep accurate notes of his work, recording the reactions and principles involved in each experiment.

Text-book.—Richter's Inorganic Chemistry.

Reference books.—Any standard works.

QUALITATIVE ANALYSIS.—The subject of qualitative analysis begins immediately after the Christmas vacation in the Freshman year and continues to the end of the school year. The student investigates the general schemes of analysis by which the various metals are detected and separated from each other; then the acid radicals are isolated and detected.

The course covers the separation of the metals and acids in solutions, dry salts and minerals, and is completed with the analysis of a few standard alloys. The student must become conversant with all the standard methods of separation with the reactions involved, and be able to write and balance equations, and to make a complete qualitative analysis of "unknowns," without the aid of notes. The spectroscope is used in connection with qualitative work for the detection of the fixed alkalies and the alkali earths.

Lectures in qualitative analysis are given, where the separations are made before the class, in order to facilitate the

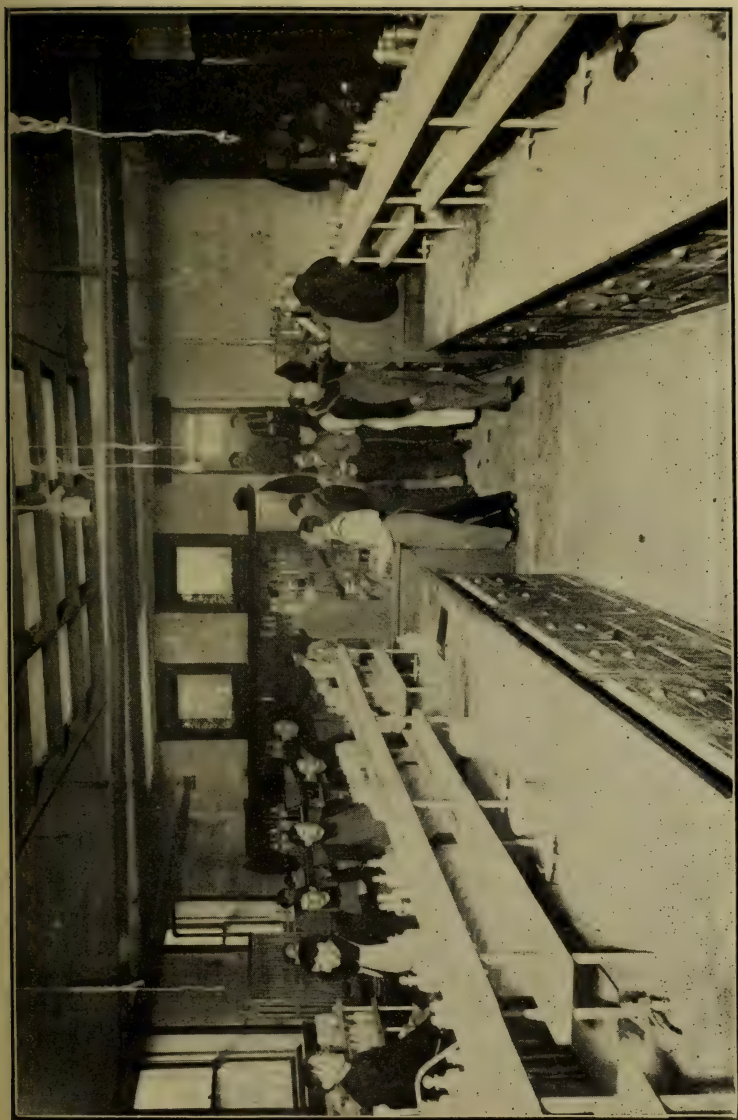
work and quickly give them correct ideas of rapid manipulation, as well as to warn them of errors into which they might easily be led. The training of the eye is very essential in this work in order to instantly detect any mistake and to be able to quickly and accurately interpret results. The lectures are followed by quizzes, where the student is thoroughly drilled in the theoretical part of the work.

Text-book.—Prescott and Johnson's *Qualitative Analysis*.

Reference books.—Any standard works.

QUANTITATIVE ANALYSIS.—Quantitative analysis extends through the whole of the Sophomore year. The work embraces all the work as carried on in the laboratories of the smelters, mills and mining plants. Our object is to thoroughly equip our students with the requisite knowledge for intelligently and successfully carrying on this work. The various products of the smelters, such as crude ores, calcines, slag, mattes, flue dust, pig iron, steels, etc., are analysed. The course covers thoroughly the subject of mineral analysis, including gravimetric, volumetric and colorimetric methods, the standardization of solutions in acidimetry, alkalimetry and cyanide work, the specific gravity of solids and solutions, by means of the balance and the hydrometer. Stoichiometry is thoroughly taught in the recitation room and problems in chemistry solved. Quizzes upon various methods of analysis will be introduced and recent literature upon chemical problems discussed. The student, after being taught the technical methods of analysis, will be required, as far as possible, to practice rapid methods and perform a large number of determinations and report them in one day, as required in actual smelter practice and mill work.

The laboratories are generously equipped with all modern appliances and conveniences and every opportunity offered for rapid and accurate work. The student has at his desk, water,



CHEMICAL LABORATORY.

sink, gas and blast, and the extent of his practical work is limited only according to his ability and industry.

Text-book.—Cairn's Quantitative Analysis.

Reference books.—Any standard authority.

METALLURGY.

The subject of metallurgy begins with the first semester of the Junior year and continues uninterruptedly for two years. The subject is presented in the form of lectures illustrated with lantern slides, with text-book work and recitations, and a large amount of practical work in the laboratory, one afternoon per week for two years being devoted to this study.

METALLURGY OF COPPER.—The study of the metallurgy of copper begins the first semester of the Junior year and continues through the term. It includes lectures and recitations covering thoroughly the entire subject, including the electrolytic refining of copper bullion. Immediately after the subject is treated in the lecture and recitation room, one week is devoted to a practical study of the smelter and electrolytic refinery at Anaconda, or the smelter and electrolytic refinery at Great Falls. Immediately following this excursion, one week is spent in studying the five copper smelters of Butte. Each operation of treatment of high grade ores directly, and low grade ores through the intermediate process of concentration, the production of matte by either the reverberatory or blast furnace, the blowing of matte to metallic copper in the converter, or the process of refining matte in the reverberatory refining furnace, the electrolytic refining of copper bullion and the separation and recovery of pure copper, gold and silver, can be studied as it passes through each step in the

process of transformation. Nearly all of the various known methods of concentrating, roasting and reduction of copper ores, are practically illustrated in the Butte smelters, or in the immediate vicinity, and no better opportunity can possibly be afforded a student for regular or special work in this line, and many take advantage of this opportunity by working in the smelters during vacation time. A detailed typewritten report is required of the class of their study at each smelter.

The subject is at present entirely covered by lectures.

Reference books.—Peters, Schnabel.

ASSAYING.—The subject of assaying begins with the first semester of the Junior year and is finished in ten weeks. We strive to give a very thorough and comprehensive course in this subject and to prepare our students to do accurate work upon entering a commercial laboratory. The subject is presented in the form of lectures and a text-book placed in the hands of the student. The practical work consists in the fire assay of gold, silver and lead in all varieties of crude ores the smelter products, such as copper and lead slags, copper and lead mattes, copper, lead and gold bullion, lead dross and speiss, calcines, flue dust, tailings, the muffle assay of coals, etc.

The laboratory is fitted with the most modern appliances, gas and coal assay furnaces, and melting and retorting furnace. Every convenience is at the command of the student and the most modern and reliable gold and silver balances are used in assay work.

Text-book.—King's Assay Manual.

Reference books.—Brown, Ricketts and Miller.

GAS ANALYSIS.—After the course in assaying is completed, the Junior class takes up the subject of technical gas analysis in the form of lectures, quizzes and the analytical work. Analyses are made of air, illuminating gas, furnace gases, etc.

METALLURGY OF GOLD AND SILVER.—The second semester of the Junior year is devoted to the study of the metallurgy of gold and silver from text-books and lectures. The practical work in this line consists in treating a given ore by the cyanide, chlorination, hyposulphite or amalgamation process, with or without roasting, and determining the comparative merits of each method upon this given ore, by check assays and analyses. If the ore is of such a nature that it will not admit of all these methods of treatment, two or more ores are used, so as to familiarize the student with each process. After the completion of the theoretical and practical work, a two weeks' excursion is taken to visit the various cyanide and other plants of Deadwood, South Dakota, or other places, where a careful study is made of the process and a detailed typewritten report is made by the class of each plant and process investigated.

The laboratory for this work is equipped with ten separate cyanide outfits, a chlorination barrel, an amalgamation plate and a calcining furnace, capable of being used as a reverberatory or muffle roasting furnace.

Text-book.—T. K. Rose's Metallurgy of Gold.

Text-book.—Collins' Metallurgy of Silver.

Reference books.—Eggleston, Louis, Eissler, Schnabel, Park.

METALLURGY OF LEAD.—The subject of the metallurgy of lead is taken up the first semester of the Senior year and completed in about 12 weeks. The subject is presented in the form of lectures and text-book work. The theoretical work is followed by metallurgical excursions to the lead smelter at Helena or the lead smelters of Salt Lake City and notes and reports required of the students covering the examinations made at the works.

After the completion of the subject of the metallurgy

of lead, the Senior class takes up the subjects of the metallurgy of iron, zinc, cobalt, nickel, aluminum, etc.

The laboratory work of the Senior class during the first semester consists in metallurgical experimentation, the basis of the work being the experiments as given in Howe's "Metallurgical Laboratory Notes."

The laboratory work of the Senior class in the second semester consists in the work of metallurgical design. A given ore, from a certain locality and containing paying quantities of any valuable mineral, is given each member of the class. He analyzes it and determines the composition and mineral values, then by suitable tests determines the best method by which the ore should be treated. He then proceeds to design a plant suitable for the reduction of this ore, calculating the cost per ton of metal to place on the market. He makes a complete report of his experiments and gives the reasons for the deductions he has drawn. All original drawings in connection with this work remain the property of the School, but the student can make and retain any blue-prints that he may desire.

Text-books.—Collins' Metallurgy of Lead, Hofman's Metallurgy of Lead, Campbell's Manuf. and Properties of Iron and Steel, Ingalls' Metallurgy of Zinc, Richard's Metallurgy of Aluminum.

GEOLOGY AND MINERALOGY.

CRYSTALLOGRAPHY.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal

systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations, receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. *Sophomore—First Semester.*

PHYSICAL MINERALOGY.—The course embraces a study of the physical characters of minerals, that is, those which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism and the action of the senses. Special attention will be given to the relations existing between these characters and the crystalline form of minerals.

Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster and fusibility, which will aid the student in the determination of minerals. *Sophomore—First Semester.*

CHEMICAL MINERALOGY AND BLOWPIPE METHODS.—The instruction in this branch treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and its accompanying apparatus and reagents. It includes, also a discussion of isomorphism, dimorphism and the genesis of pseudomorphs. In the laboratory the student becomes familiar with the reactions of the important elements by means of the use of known minerals. *Sophomore—First Semester.*

DETERMINATIVE MINERALOGY.—This course is wholly laboratory work. The student is given actual practice in the determination of minerals by their chemical and physical characters. He is expected to become thoroughly familiar with the common and important minerals so that he will recognize them at once. *Sophomore—Second Semester.*

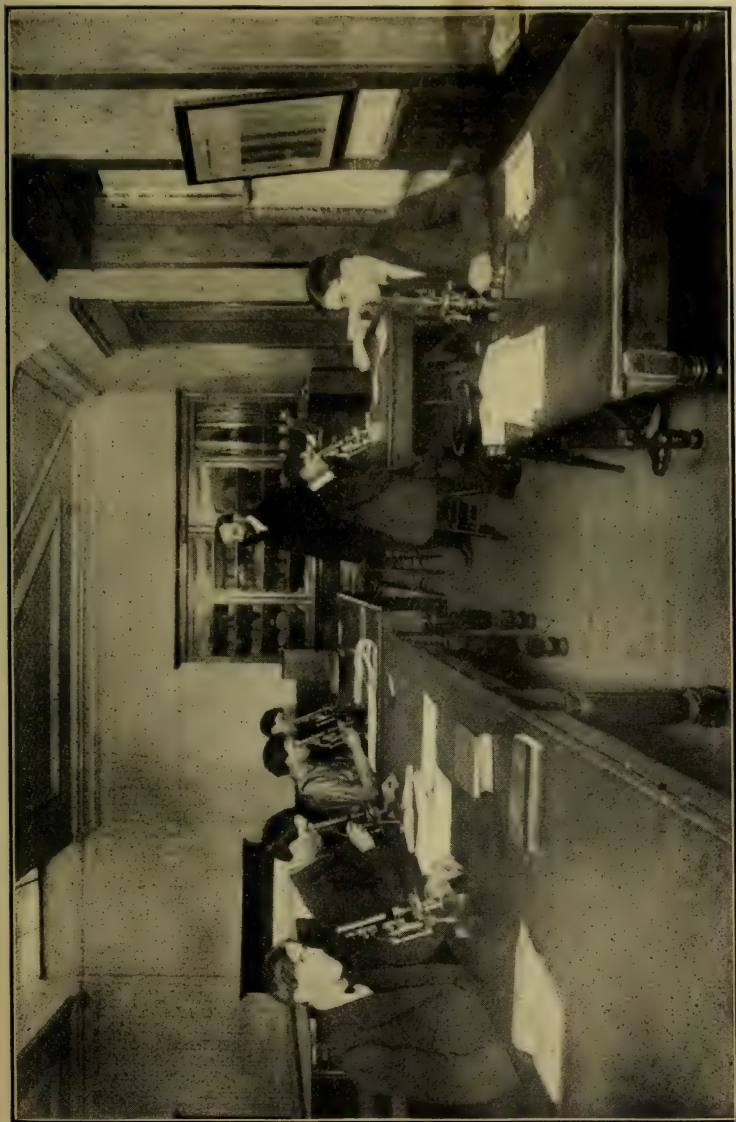
DESCRIPTIVE MINERALOGY.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification and uses. The object of the course is to give the student a practical knowledge of the characters, occurrence, etc., of the commoner minerals. *Sophomore—Second Semester.*

PHYSICAL GEOLOGY.—This course treats of the origin and alteration of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, mountain building, action of air, the surface and underground waters, and life, the interior condition of the earth, etc., especially in their relations to the problems that the mining engineer, economic geologist and quarrymen, have to meet. Scott's Introduction to Geology. *Junior—First Semester.*

HISTORICAL GEOLOGY.—The instruction in this subject will be given by means of lectures and recitations. The main object of the work is to familiarize the student with the life history of the earth, and with the mode of formation, order of superposition, times of upheaval, distribution in time and space, and characteristic fossils of the formations which compose the earth's crust. Scott's Introduction to Geology. *Junior—First Semester.*

ECONOMIC GEOLOGY.—In this course the uses and commercial value of mineral products are especially emphasized. The course includes a study of the common rock and vein-forming minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. *Junior—Second Semester.*

PETROGRAPHY.—This course is introduced by a review of the principles of optics, including the propagation of light, total reflection, refraction, polarization and dispersion. The



LABORATORY FOR PETROGRAPHY.

student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lens and the camera lucida. He must also become acquainted with the method of preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form and habit, cleavages and parting, color and pleochroism, refraction and birefringence, positive or negative character, and uniaxial or biaxial interference figures, and their dispersion. When able to recognize promptly the important rock-forming minerals, the student is prepared for the microscopical study of rocks. The course is accompanied by a brief study of the methods of determination of the various elements and minerals by chemical reactions with minute quantities under the microscope. *Senior—First Semester.*

PETROGRAPHY, ADVANCED COURSE.—The chief object of the advanced course in this subject is to train the student to rapidly identify crystalline rocks by means of the microscope. Attention will be directed especially to the igneous rocks. Various systems of classification will be studied, and their fundamental principles compared. The mineral composition, both qualitative and quantitative, the estimated chemical composition and the crystalline texture will demand attention. The student will then study in detail typical examples of each of the important rock families. *Senior—Second Semester.*

FIELD GEOLOGY.—Study of a selected area in the vicinity of Butte. Practice in observing geological features and in interpreting them. Geological mapping. *Summer course of four weeks.*

MECHANICS.

PHYSICS.—The subject of Physics is introduced in the Sophomore year. Throughout the course the student's atten-

tion is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown, and finally enter the laboratory and make a series of physical measurements. While the whole subject of physics is covered, it is the aim to develop most thoroughly such parts as may add directly to the working knowledge of the mining engineer. The department is equipped with a fine assortment of modern apparatus both for the lecture demonstrations and for the individual work in the laboratory.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. The subjects of heat and light are also introduced. Aside from the nature and measurement of heat, its application to the steam-engine is considered, and a study is made of the properties of gases and the transmission of energy by means of compressed air. The work in light includes a study of optical and engineering instruments and of the phenomena developed in the study of mineralogy.

The second semester is occupied with a study of electricity and magnetism. This course includes a study of the principles underlying the application of electricity to engineering problems, as haulage, the transmission of energy, lighting, etc. During the second semester also the class work of the year is supplemented by practice in the laboratory. Constants in the domain of mechanics, heat and light, are determined and a familiarity is acquired with simple electrical measurements, the running and behavior of motors, the running and characteristics of dynamos, etc.

ANALYTICAL AND APPLIED MECHANICS.—During the Junior year an extended study is made of Analytical and Applied Mechanics, particular attention being paid to such topics as are useful in the designing of machinery and structures

connected with mining and mill work. The first semester is occupied in part by a study of Elementary Statics, Kinematics and Kinetics. The course in Statics deals with conditions of equilibrium, composition and resolution of forces acting on a rigid body, center of gravity, friction, principle of virtual velocities, simple machines, the funicular polygon, etc. After a brief analytic treatment of Kinematics, problems involving the principles are studied; pure rolling in direct-contact mechanisms, frictional gearing, outlines of gear teeth, cams, linkwork, belts, ropes etc. The subject of Kinetics embraces the laws of motion, impact, moments of inertia, rotary motion etc.

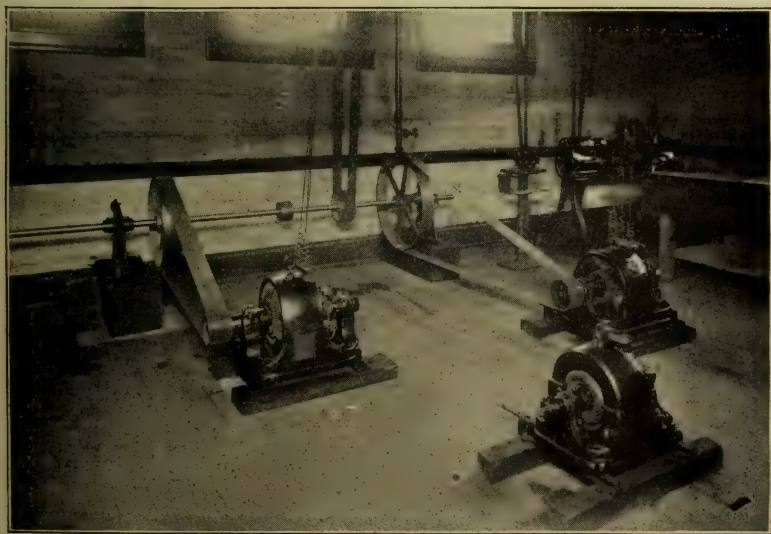
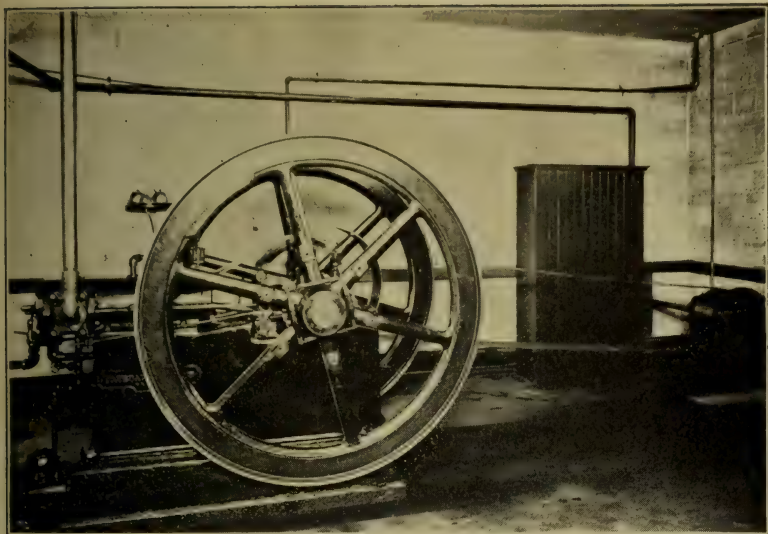
The second semester is given up to the study of the Mechanics of Materials. Application is made to the study of the resistance and elasticity of materials, to the proportioning of pipes, cylinders and riveted joints, to cantilever beams, simple beams, restrained beams, continuous beams, columns, torsion and shafts, combined stresses, the resilience of materials, torsion and compression, flexure of beams, shear and torsion, apparent stresses and true stresses, etc.

MECHANICAL ENGINEERING OF POWER PLANTS.—The discussion of the power plant is preceded by a course of lectures and recitations on Thermodynamics. Attention is paid to the definitions and units in the domain of heat, work, and power. The laws of thermodynamics are thoroughly developed and numerous problems are solved in connection. Following this course a systematic study is made of the mechanism of engines, non-condensing, condensing, simple, and continuous expansion engines, valves, and valve gearing with their various governing attachments, engine foundations, bed-plates, etc. Steam boiler types are studied together with their setting, management, etc. The designing and construction of chimneys and the general plans for power houses are also made a part of this course.

During this course a series of lectures is offered, essentially descriptive of pumps and pump details, special attention being given to the construction and management of mining pumps. The course is based on, "Pumping Machinery," by William M. Barr.

GRAPHICS.—The work in Graphics follows the Junior course in Mechanics. The course is intended to familiarize the student with graphical methods of obtaining the stresses in the members of any of the common structures intended to support a load above an opening,—a roof, bridge, or truss. A detailed study is made of the proportions of the various standard roof trusses, attention being given to loads due to materials, wind, snow, etc. Analysis is made of single-span trusses of various types with horizontal chords, trusses with inclined chords, and continuous trusses. In these problems concentrated and uniform loads are considered, stresses due to a locomotive, also stresses due to wind, etc. The work is carried out in the drawing room supplemented by lectures and recitations.

POWER TRANSMISSION.—The extensive use of electric power, together with the abundant water supply for power purposes in the West have prompted us to give rather extended attention to this branch of engineering. The elementary principles are laid down during the Sophomore year. In the Senior year the student's attention is directed to the general conditions of power transmission, power transmission by continuous current, some properties of alternating circuits, power transmission by alternating currents, synchronous and induction motors, current reorganizers, hydraulic development, the organization of a power station, line construction, centers of distribution, the commercial problems, and measurement of electrical energy. The numerous electrical plants about Butte offer opportunities for observing most excellent practice in this line of engineering.



POWER AND DYNAMO ROOM.

TESTING LABORATORY.—One afternoon each week during the first semester is given to work in the testing laboratory. The course is designed to cover experimentally the formulas derived in the courses in mechanics and to investigate the elastic properties of building materials. The students are required to make up standard forms of iron, steel, etc., for tensile, transverse, and compression tests. Building stone, brick, cement, and timber are investigated. A part of the course consists in making dynamometer tests of an engine and in determining the characteristics of dynamo machinery.

MINING AND MINING ENGINEERING.

Instruction in mining and mining engineering is given by lectures and recitations, by laboratory work, by excursions to mines within easy reach of the students and by practical work during the summer vacation.

An outline of the work is as follows:

ELEMENTS OF MINING.—Lessons are assigned on the geographical and geological distribution of the ores of the useful metals. The subjects of prospecting, locating and acquiring title to mining claims are next considered. Then follows a course of lectures designed to familiarize the student with the nomenclature of the subject and to outline to him the principal methods of exploitation.

MINING.—Following the preliminary work outlined above, the subject is considered in detail. Running parallel with the text, lectures and notes are given to the student and the work is illustrated by drawings, prints, models and frequent visits to local mines, where mining operations are observed.

The subjects covered include boring, breaking ground, supporting excavations, exploitation, winding, transportation, drainage, ventilation and illumination.

Three hours each week, Second Semester, Junior year, and for nine weeks, First Semester, Senior year. Foster's Ore and Stone Mining.

MINE SURVEYING AND MINING.—The work comprises a course of lectures on mine surveying with drawing room work in the solution of numerous problems, exercises in platting and a study of mine models, followed by practical work in the execution of mine surveys and study of mining operations. The school has not only models of different mines, but, in one case, no less than four different models of the same mine; hence the comparative merits of model types can be studied to advantage.

Of the six weeks devoted to practical work, four are spent in making a survey and preparing the maps of some mine. The remaining two weeks are devoted to the study of mining operations at the mines.

Three hours a week, Second Semester—Junior year and fifty hours a week, six weeks, Junior vacation.

MINING ENGINEERING.—Instruction is given by lectures and recitations, study of professional papers, and excursions to mines in Butte and vicinity. The following is an outline of the course:

Mine Plant.—The design and arrangement of plant including boiler plant, hoist head frame, underground and surface ore bins, compressor, trackage, means of lighting, ventilating, signaling, pumping, timber framing and repairing.

Operation.—Organization, management and accounting. Leases, options, royalties. Examination and reports.

Five hours a week, Second Semester—Senior year.

ORE DRESSING.—Recitations and laboratory work on the art of Ore Dressing and ore dressing machinery.

Few, if any, localities afford better opportunities for the student to study the details of the dressing of sulphide ores. The managers of local concentration plants have shown the greatest courtesy to the students of the School of Mines. It has been their custom to permit the students to visit their mills and engage in comparative trials of ore dressing machines under the conditions of actual practice.

The subject, in outline, is as follows:

Ore Dressing Machinery.—The construction and operation of the principal types of crushers, rolls, stamps, screens, classifiers, jigs, vanners and concentrating tables.

Principles of Ore Dressing.—Followed by a study of the design and operation of several mills.

Ore Dressing Laboratory.—Laboratory work in concentration and practical work in stamp mills.

Three hours a week, nine weeks, First Semester of Senior year and three hours a week, Second Semester of Senior year. Richard's Ore Dressing.

HYDRAULICS.—A knowledge of the subject of hydraulics is of paramount importance to the mining engineer, particularly to him whose field of labor is in the west. In the course as outlined below particular attention is devoted to the study of the subject as applied in the arts of mining and ore reduction. Opportunities for practical work and observation within easy reach of the student of the Montana State School of Mines are unexcelled.

1. Hydrostatics.

2. Theoretical Hydraulics; a study of the laws of the flow of water through orifices, pipes, conduits and canals; water power and water motors.

3. Measurement of water by weirs (Field Practice).

4. Dams for water supply, mining power purposes and for impounding tailings.

5. The design of ditches, flumes and launders for supplying ore reduction plants and for the conveyance of wood, ash, tailings and slags.

6. Domestic supply and sewerage for mining camps; pollution of streams by mining or metallurgical refuse.

7. Water rights; location and title under the laws of the State of Montana.

Text-book.—Merriman's Treatise on Hydraulics.

Three hours per week, Second Semester—Junior year.

SURVEYING.—The course begins in the second semester of the Freshman year and is designed to give the student a thorough preparation for the field work at the end of the year. The class room work consists of lectures and recitations.

1. Surveying instruments; their construction, adjustment, use and care.

2. Forms of field notes for different methods of surveying and levelling; office forms for computations.

3. Reducing and platting the notes in the drawing room (see topographical drawing); computation of areas.

Text-book—Johnson's Theory and Practice of Surveying.

Three hours per week, Second Semester—Freshman year.

Surveying.—(Theory and Practice.)—Practical work in the execution of surveys with lectures and recitations. One hour each day is spent in the recitation room, the remainder of the time in the field or in the drawing room. The student is required to execute the following surveys and prepare where necessary, maps, profiles and complete reports.

1. Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain.

2. Adjustment of hand level, compass, wye level, transit and sextant.
3. Reading angles, horizontal and vertical.
4. Traverse survey with compass and chain.
5. Determination of meridian by solar observation and by observation on Polaris.
6. Traverse survey with transit and steel tape, angles by repetition, azimuth and by deflections.
7. Official survey of mining claim in application for U. S. patent; returns to consist of letters of transmittal, plat, field notes and computations; in form for transmission to U. S. Surveyor General.
8. Subdivision of a section of the public land according to Manual of Instructions to U. S. Deputy Surveyors.
9. Topographic survey with transit and steel tape.
10. Laying out a townsite, the plat to be prepared in shape for filing with Clerk and Recorder.
11. Levelling for profile and to fix grade, location of bench marks and contours.
12. Staking out excavation for foundation and determining volume of such excavation.
13. Staking out wagon road, irrigation ditch and flume line. Grades given or assumed, volumes to be determined from cross sections, costs to be estimated.
14. Determination of volume of a dam, a reservoir and an ore or waste dump by cross sections and approximately by contours with use of planimeter.
15. Railroad Survey.—A line about 5 miles long is located and cross sectioned.

Text-books.—Johnson's Theory and Practice of Surveying.

Searles' Field Engineering.

Fifty hours a week, six weeks, in the summer vacation
—Freshman year.

TOPOGRAPHICAL DRAWING.—This subject follows the class room work and field in Surveying. The student is given the field notes of actual surveys, forms for the office work of reduction are provided, and he is required to reduce and plat the notes. The work comprises:

1. Making topographical signs, for the usual conventional surface representation and including additional conventions required by the mining engineer such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, etc. The methods of the U. S. Coast and U. S. Geological surveys are followed in this work.
 2. Map Construction.—Making scales, plotting by polar and rectangular co-ordinates, lettering, titles, borders, corners and north points.
 3. Platting Notes of Summer Field Work.
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DRAWING AND DESIGNING.

The primary object of instruction in these subjects is to develop the skill necessary in the practice of the engineer; to this end a portion of each term through the whole course is spent in the drawing room working out problems which go hand in hand with class room work. The major part of the work is therefore confined to mechanical and topographical drawing, at the same time it is designed to develop neatness and speed.

When providing himself with drawing instruments it is recommended that the student should purchase only those of good grade; a substantial set of instruments if well cared for, will last throughout the course and for many years of subsequent practice; cheap and inferior instruments are a source of annoyance and loss of time.

The following list of instruments is recommended, other minor necessities may be supplied as suggested:

- One $5\frac{1}{2}$ inch compass.
- One $3\frac{1}{4}$ inch bow spacer.
- One $3\frac{1}{4}$ inch bow pencil.
- One $3\frac{1}{4}$ inch bow pen.
- One 5-inch ruling pen.
- One 6-inch metal protractor.
- One 8-inch $30^{\circ}\times 60^{\circ}$ amber triangle.
- One 8-inch 45° amber triangle.
- One K. & E. curve No. 20.
- One triangular scale graduated to 12ths.
- One T square, 36-inch blade.
- One board, 24x32 inches.

Mechanical Drawing.—During the first semester of the Freshman year the student recites three hours each week on the problems of Descriptive Geometry and applies himself six hours each week in the drawing room working problems involving projections, sections, intersections, developments, etc.

Six hours per week through the second semester are assigned to making isometric and oblique projections, lettering, tinting, conventions for wood, metals, masonry, etc. Plans, elevations and sections of some simple structure are also completed.

Machine Design.—The elements of Mechanism and Machine occupy three hours per week during the first 10 weeks of the first semester, Junior year, and nine hours per week during the remainder of the semester. The work consists of the designing and drawing of standard parts of machines. Each problem requires the working out of the part for a specific use, examples of which may be examined on some of the School's machinery. The course includes the designing of screws, nuts, bolts, keys, cotters, gibs, rivets and riveted joints, shaft couplings, bearings, gearing, engine details, etc.

Design and Construction.—The design and construction of mining and ore reduction machines; cars, skips, cages, brakes, sheaves, drums, pipe lines, receivers, expansion joints, crushers, rolls, screens, jigs and concentrating tables. The application of the student's knowledge of machine design to these machines and appliances forms a portion of the subject matter of the work in mining and ore dressing.

There are available for the student's use a large number of working drawings of various kinds of mining and ore dressing machines; opportunity is afforded by the local shops to observe the work of assembling the details of most machines above mentioned.

Lectures and drawing room practice.

Six hours a week, second semester, Junior year.

Mining Engineering Design.—The course accompanies the work of the student in mining engineering. Beginning with lectures and drawing room practice in the design in wood, metal and masonry, of such structures as are within the ordinary wants of the mining engineer; the work leads up to the design and arrangement of plant for one or more of the operations of mining or ore dressing.

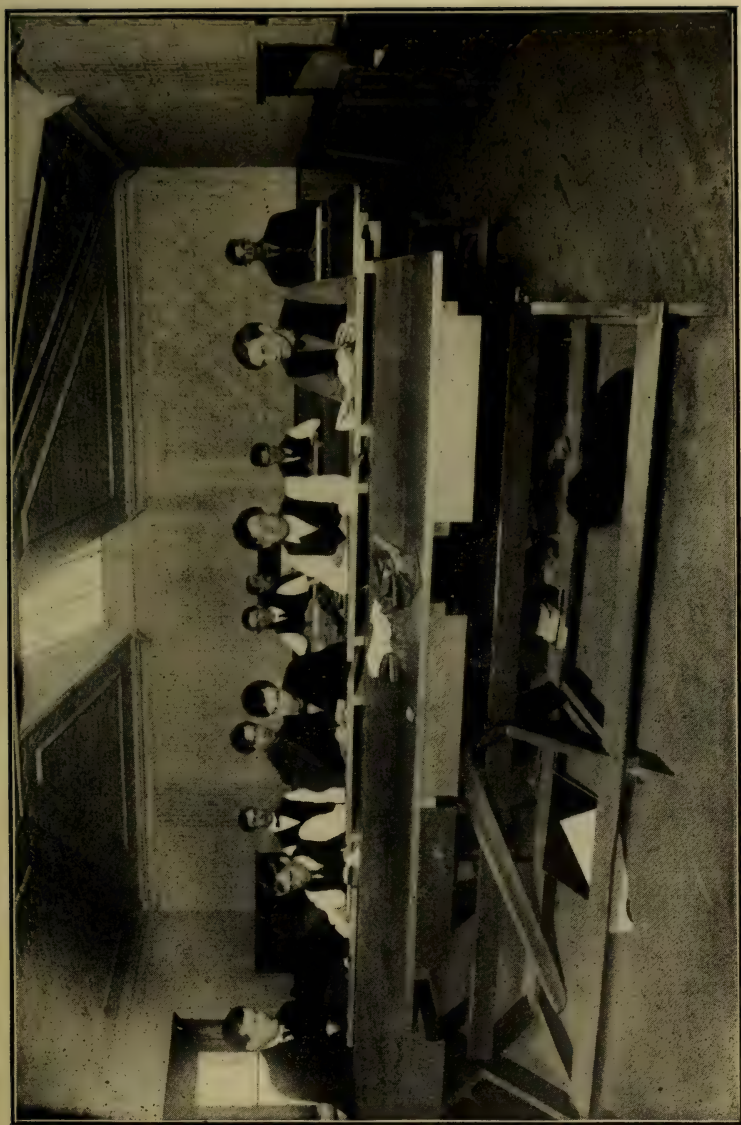
Lectures and drawing room practice.

Six hours a week, first semester of Senior year.

MINING LAW.

The proper construction of the mining laws of the United States is a subject of great importance not only to the mining engineer, but to all who are interested in the ownership or control of mining property.

The Trustees of the School of Mines have inaugurated a course of lectures on this subject and have secured the ser-



FRESHMAN DRAUGHTING ROOM.

vices of Judge J. B. Clayberg as lecturer. His Course of lectures embraces the following topics:

How a mining right may be initiated.

By whom and upon what land.

How it may be continued or lost.

How it may ripen into an absolute title.

What rights may be acquired in cross-veins and veins uniting on the dip.

What rights are acquired under tunnel claims and rights.

What are extra-lateral rights and when do they attach.

Rights of inspection and survey of adjoining mines.

How title is acquired in coal lands.

Mining partnerships.

A general treatment of other subjects especially bearing on the law of mines on the public domain of the United States.

EQUIPMENT

The equipment of the School of Mines has been secured through appropriations made by the legislature of the State. The total sum invested for this purpose now amounts to nearly \$40,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The lists that follow represent only a few of the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

MATHEMATICS.—The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of Engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

CHEMISTRY.—In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigating is very great, and the successful prosecution of the purpose for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been devoted to the use of this department, together with a lecture room on the second floor. In this space four laboratories have been fitted up, one for qualitative and quantitative analysis, one for metallurgy and two professors' laboratories.

To these have been added a balance room, a store room

of laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast. Bunsen burners, a rack for chemical reagents and a cupboard with lock and key, so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The laboratories for qualitative and quantitative analysis and for metallurgy are sufficient for the accommodation of 48 students each.

The students' balance room is provided with six analytical balances for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls or floor of the building so that the vibration is reduced to a minimum.

The professors' private laboratories and preparation rooms are equipped with modern conveniences for carrying on analytical work. In these rooms all the chemical reagents are prepared for the use of the students in the laboratories, and all check analyses on the students' work are made. Two dark rooms are provided for photographic work, spectrum analysis, making blue prints and lantern slides.

The Chemical Lecture room, located on the second floor, is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

METALLURGY.—The assay laboratory is situated on the

first or basement floor of the building, and is equipped with six of the latest modeled coal assay furnaces. There are also two gas assay furnaces, which can be used for special work, and a gas retort and melting furnace for melting bullion, making alloys, retorting amalgam, casting copper and other anodes, etc.

The pulp room adjoins the assay laboratory, where all charges are weighed and fluxed. Convenient cupboards are provided for storing samples. The silver and gold balances are located in the same room as the analytical balances, and are of the latest approved design, with agate bearings.

The ore dressing room is provided with a Gates crusher, a Low crusher, an Englebach grinder, capable of grinding pulp to 80 mesh, a buckboard, tables upon which to roll samples, and a series of drawers capable of holding 464 twenty-five pound pulp samples. Our supply of assay samples consist of a large number of copper, lead, gold and silver ores, together with mattes, both copper and lead, slags, flue-dusts, calcines, concentrates, tailings and all smelter products from the copper and lead smelters and other plants of the State. Each student is required to collect, crush, grind and buck five twenty-five pound samples in the assay course, and to cut down and assay these samples.

In the assay laboratory are located ten separate cyanide outfits for testing 50 to 100-pound lots of ore by the cyanide process. Also a chlorination barrel in which 100-pound lots can be tested by this process. There is also located in this laboratory, a calcining furnace capable of being used as a reverberatory or muffle roasting furnace, where large lots can be simply calcined, or a chlorination roast can be made by the hyposulphite treatment. We have arrangements for treating free milling gold ores by the amalgamation process, as well as cyaniding the tailings from this process.

Gas analysis is at present carried on in the chemical lecture room. We have a very complete set of Hempel's

gas apparatus and analyses are made of gases of combustion, reverberatory and blast furnace, and illuminating gases, as well as air, etc.

A dark room for student's use adjoins the balance room, which contains a large Kirchoff-Bunsen spectroscope and supplementary apparatus for qualitative analytical work in determining the presence of the alkali and alkaline earth metals by their volatilization in the non-luminous flame of the Bunsen burner. The spectroscope is provided with a scale for the determination of the exact location and relative position of the lines of the spectra, or, two spectra may be studied and compared at the same time.

Students are not permitted to do any work other than that outlined in the regular courses, except under the direction of the professor in charge.

GEOLOGY AND MINERALOGY.

To this department has been assigned:—a large room on the first or main floor as a museum, three rooms on the second floor, viz.: a lecture room, an office and supply room, and a mineralogical laboratory, and four rooms on the third floor. These rooms are designated as the thin section lathe room, the dark room, the storage room, and the petrographic laboratory.

The museum is occupied by models of mining properties in Butte, a large geologically colored topographic model of the United States, and various collections of ores, minerals, rocks and fossils. There are six mine models, namely:

1. Black Rock-Niagara model, constructed by R. G. Brown, for the Niagara Mining Company.

- 2, 3. Colusa Parrot-Never Sweat models, made for

the Colusa Parrot Mining Company, one model to show the workings and another to show the economic geology of the mines.

4. Colusa Parrot-Never Sweat model, made for the Anaconda Copper Mining Company in the style of a single block, representing the surface of certain mining claims and the solid rocks and veins vertically beneath the given surface for eighteen hundred feet. The block is then cut in two planes to show the conditions in these vertical sections.

5. Colusa Parrot-Never Sweat model, made for the Colusa Parrot Mining Company, showing all the workings of both mines to a true scale. This model is accompanied by a map of workings in the Colusa Parrot district, made for the same company.

6. Pennsylvania-Rarus model, made for the Boston & Montana Consolidated Copper and Silver Mining Company, showing the workings of these mines.

There are two other models, namely:

1. Model of Holthoff-Wethey calcining furnace, as in use at the Butte Reduction Works, showing the device by means of which the rails and wheels supporting the harrows are kept outside the furnace proper.

2. Model of the Pratt centrifugal ore sizer, as in use at the Butte Reduction Works, for sizing ore before it is run over Wilfley tables.

There is also a large diagram showing an "Ideal Section of a Butte Copper Vein," constructed by the Geological Department of the Anaconda Copper Mining Company. This diagram has been reproduced in one of the mining journals and also in the latest textbook on economic geology.

Several appropriate photographs and drawings decorate the walls of the museum and library; these include views of



ON A GEOLOGICAL TRIP.

Montana mining towns, of the Washoe smelter at Anaconda, of the Boston & Montana smelter at Great Falls and of various mines and mills about the State. There is a large drawing to illustrate the method of sampling in use at the Taylor & Brunton Sampling Works (now the Washoe Sampling Works) at Butte, and also several drawings of the coal washery of the Cottonwood Coal Company. Finally there are several diagrams, illustrating the relative production of copper, silver and gold in Montana and other states.

A very complete series of the products of the metallurgical processes in use at the Boston & Montana smelter at Great Falls is installed in one of the museum cases; there are also several views of the interior of the smelter and adjoining properties, as well as a flow sheet of the concentrator.

The Butte Reduction Works is represented by a large number of its metallurgical products, including concentrates, tailings, mattes, sulphur coated ore, etc. The products of the Washoe smelter are also shown, including samples of the copper cakes and anodes produced at Anaconda.

The material now belonging to the museum is so extensive that at least half of it has been crowded out of the main museum room into other rooms. The different coal fields of the state are represented by samples of coal; one case shows assorted sizes of coal from the property of the Cottonwood Coal Company at Stockett, Montana. Another interesting specimen shows a portion of a tree trunk converted into coal.

Corundum ore and sized corundum from near Bozeman is shown in comparison with products of the corundum mines of Canada. Building stones of Montana are represented by a few samples. Various rare minerals from the state are included in the collections of the School.

Gold, silver, copper and lead ores from all parts of Montana occupy several large cases; these represent practically all the important districts and mines in the State, as well as many important mining districts outside the State.

Finally the museum contains several special collections of minerals and geological specimens. Amongst these may be enumerated:

1. A series of fossils representing all geological horizons.
2. A collection of rocks, illustrating the phenomena of physical geology.
3. A series of fossils from the tertiary basin of Paris.
4. A collection of rocks illustrating all petrographic types.
5. A systematic collection of minerals.
6. A collection of common rocks for class study.
7. A collection of crystals illustrating all the common crystal forms of minerals.

The lecture room on the second floor is seated for the accommodation of forty students, is provided with large blackboards, and with geological diagrams and maps.

The office and supply room contains:

1. Library of geology and mineralogy, including a large number of text books and monographs, and a goodly share of the official geological publications.
2. Extensive collection of minerals, classified according to their chief base present, for class use.
3. Collection of ores of special districts.
4. Three series of crystal models.

5. Collection of minerals for blowpipe analysis.
6. Chemicals and blowpipe apparatus.
7. Hydraulic blast, hood, oven with automatic temperature regulator, combustion furnace, etc.

The mineralogical laboratory is furnished with:

Six modern blowpipe laboratory tables each 11 feet long by 4 feet wide by 5 feet high, provided with water and gas. The table tops are of plate glass with aluminum rims—each table will accommodate six students at one time:—

Complete apparatus for each student.

An analytical balance, two Jolly balances, three Plattner scales, hydraulic blast, hood, Westphal balance, application goniometers, etc.

A collection of minerals to illustrate all their physical characters.

To facilitate the work in crystallography an application goniometer is at hand, and the students are urged to obtain Penfield goniometers for personal use; the department has, further, three sets of crystal models, illustrating the axes, and the fundamental forms of all the systems, all the forms of the regular system and all the most important forms of the other systems. For the use of advanced students a large size Mallard reflection goniometer is installed in the dark room on the third floor.

The elaborate mine models in the museum, as well as various other models, maps and charts, are of especial value to the students of economic geology. But the most important part of the equipment for this study is furnished by the famous silver and copper mines of Butte, the owners of which have shown themselves extremely friendly to the School of Mines, offering every facility to the students for investigation and study of actual geologic conditions.

The Ward collection of rocks illustrating geological phenomena of all kinds, and a large lithological collection are important aids in the study of dynamic geology and lithology, respectively. In these subjects, also, the Butte district furnishes many varied object lessons.

For the study of petrography the department is provided with rock cutting and rock grinding machines, which are operated by means of an electric motor; each student is expected to learn to make his own thin sections of rocks and minerals. At the same time several series of thin sections already prepared are available for study. These include:

1. A series of 336 thin sections with accompanying rock samples arranged to illustrate all the petrographic types as described by Rosenbusch.
2. A series of oriented thin sections of important rock-forming minerals.
3. Other thin sections of rocks and minerals, about 400 in number.

The latest model French microscopes are employed for the microscopic studies of rocks and minerals. All the useful accessories for this work are at hand, including the Bertrand lens, the Federoff inclining stage, the Michel Levy compareteur, the Lacroix axial goniometer, the Levy and Lacroix birefringence color chart, and a microphotographic apparatus. In order to permit convenient use of the last a dark room has been fitted up in the third story; it serves also for goniometric practice and photographic work.

The department has recently increased the number of microscopes available for this work. For work in economic geology and for the Summer work in field geology some instruments and tapes have been secured, including a Brunton compass, an Attwood clinometer, an Abney mine level, and an aneroid barometer.

MECHANICS.

This department occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons, and is provided with modern lecture room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy tables and apparatus for the measurement of physical constants. The apparatus consists of the usual assortment required in the measurement of density, elasticity, force of gravity, the latent heats of fusion and evaporation, the mechanical equivalent of heat, etc. There is also a good photometer, together with the necessary accessories. For the measurements in electricity, there is provided ammeters, voltmeters, resistance boxes, Wheatstone bridges, galvanometers, batteries, keys, etc.

The engine and dynamo room is located in the basement of the building; there is installed here a gas engine of fifteen horse power, from which is belted a line shaft driving direct and alternating current dynamos. A switchboard connects these machines with lines running to various parts of the building, also to motors and a rotary converter and to a bank of transformers. It is possible to illustrate most of the connections in power transmission systems with the apparatus at hand as well as to perform many interesting tests. A storage battery of ten cells is also connected to the switchboard so that any number of them may be connected to any of the circuits for lecture or experimental purposes. The requisite voltmeters and ammeters for both alternating and direct current, rheostats, etc., are provided. The laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements.

In connection with this laboratory there is a small shop equipped with the following metal working machines; one

thirteen-inch screw cutting lathe; one sixteen-inch shaper; one twenty-two inch drill. The tool cabinets are provided with a good equipment of bench tools for both metal and wood work. There is also a small blacksmith shop used for making and repairing tools and for giving such students as may desire it, practice in forge work in iron and steel.

In addition to the material mentioned above the testing laboratory has at its disposal a 100,000-pound Olson machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Olson compression micrometer especially designed for measuring the compression of stone cubes and other building material; one Olson improved deflection instrument for measuring the deflection of beams subjected to load; one Henning's improved micrometer instrument for measuring the compression or elongation of long specimens. The laboratory is also equipped with a cement testing outfit from Fairbanks, Morse & Co. All accessories, such as molds, sieves, etc., are at hand for making a thorough study of this important subject. The apparatus for making a complete indicator and brake test of an engine are provided, also the apparatus for making a study of the heating power of coals.

MINING ENGINEERING.

A room 32 feet by 108 feet on the third floor is being fitted to serve as an ore dressing laboratory and model room, in which students of the Senior and Junior classes will have an opportunity to make laboratory tests on the mechanical preparation of ores preparatory to subsequent metallurgical treatment. In addition, opportunities will be afforded for the study of the working of mining, ore dressing and hydraulic machines or models of the same.



BALANCE AND TESTING ROOM.

Drawing Rooms.—The drawing classes occupy one large, well-lighted room, 30 feet by 60 feet, on the third floor and one room, 30 feet by 30 feet, on the second floor. Ample table room and individual drawer room are provided throughout; cabinets for filing drawings and drawing boards are also provided. A large collection of drawings furnished by various manufacturing companies of mining machinery is on hand and used as an aid to the student in developing new work. The collection of parts of machines is gradually increasing. This material is of great assistance to the department in developing the work in machine design.

For the practical work in surveying the following has been provided: Six engineers' transits; one from Buff and Buff, one from C. L. Berger & Sons, three from Gurley, and one from Keuffel and Esser. Four levels—One from Buff, one from Gurley, one from Keuffel and Esser and one from Berger. One solar compass and one sextant with artificial horizon, from Gurley; two aneroids by Short and Mason (London), and a collection of minor apparatus, including Brunton compass, clinometers, Locke levels, chains, tapes, plummets, shaft plumbing equipment, rods and flags, necessary in carrying on the work of the department.

THE LIBRARY.

The library of the School of Mines has a nearly complete collection of the recent official surveys and Scientific Reports of the State and United States. This embraces Reports of the State and the United States Geological Surveys, the U. S. Coast and Geodetic Surveys, Reports on Forestry, Forest Reserves, Irrigation and the Naval Observatory; also official Scientific Reports of many of the States and of Great Britain, Canada, Australia, New Zealand, France and Mexico.

The leading Scientific, Mining Engineering and Geological Magazines are to be found on the Library tables, and as fast as the several volumes of these are completed they are bound and thus furnish in permanent form more or less complete discussions of the latest and most important advances that have been made in their several departments. To these are added the bound volumes of the proceedings of the great Scientific Societies, such as the Geological Society of America, the American Chemical Society, and the American Institute of Mining Engineers, etc.

A valuable collection of the standard works and treatises on the various branches of Science taught in technical schools has been secured by purchase or donation.

THE MARCUS DALY COLLECTION.

This collection of technical scientific books was purchased from a fund of \$300, donated by Mrs. James W. Gerard, of New York City, and is named in honor of her father, the late Marcus Daly. To this have been added other technical works purchased from the surplus of the registration fees of the School of Mines.

MAGAZINES.

The following technical and general magazines and periodicals will be found in the library and in the rooms of the members of the faculty, where they may be freely consulted by the students:

American Journal of Science.
American Review of Reviews.
Annales de Chimie et de Physique.
Annals of Mathematics.
Berichte d. d. Chemischen Gesellschaft.
Bulletin de la Societe Geologique de France.
Bulletin de la Societe Mineralogique de France.

Bulletin of the Geological Society of America.
Cassier's Magazine.
Chemical News
Comptes Rendus.
Economic Geology.
Electrical World.
Electrical Age.
Electrician.
Engineering—London.
Engineering and Mining Journal.
Engineering Magazine.
Engineering News.
Geological Magazine.
Indian Engineering.
Iron Age.
Iron and Steel Magazine.
Iron Trade Review.
Journal of American Chemical Society.
Journal of the Chemical Society of London.
Journal of Geography.
Journal of Geology.
Machinery (Engineering Edition).
Mineral Industry.
Mineralogical Magazine.
Mines and Minerals.
Mining and Scientific Press.
Mining Magazine.
National Geographical Magazine.
Nature.
Neues Jahrbuch fur Geologie, Mineralogie, etc.
Outlook.
Popular Science Monthly.
Quarterly Journal of the Geological Society of London.
School of Mines Quarterly.
Science.
Transaction of the American Institute of Mining Engineers.
Tschermak's Petrographische und Mineralogische Mittheilungen.
Zeitschrift fur Krystallographie.
Zeitschrift fur Praktische Geologie.

The following newspapers are kindly furnished by their publishers free of charge:

The Ravalli Democrat (weekly), Hamilton.
Great Falls Leader (daily), Great Falls.
The Missoulain (daily), Missoula.
Blue Mountain American (weekly), Baker City, Oregon.
The Tribune-Review (weekly), Butte.
The Evening News (daily), Butte.
The Basin Progress (weekly), Basin.

DONATIONS

DONATIONS TO THE LIBRARY.

Valuable gifts of books, reports and pamphlets have been received during the year beginning May 1, 1905, and ending April 30, 1906, from:

William Anderson, Government Geologist, Pietermaritzburg, Natal, South Africa.

Lewis C. Aubury, State Mineralogist, Sacramento, California.

Robert Bell, Director, Geological Survey, Ottawa, Canada.

A. E. Birge, Director, Geological Survey, Madison, Wisconsin.

W. S. Blatchley, State Geologist, Indianapolis, Indiana.

H. Y. L. Brown, Government Geologist, Adelaide, South Australia.

E. R. Buckley, State Geologist, Rolla, Missouri.

Richard Batten, Minister for Mines, Adelaide, South Australia.

Samuel Calvin, State Geologist, Iowa City, Iowa.

William B. Clark, State Geologist, Baltimore, Md.

Oscar J. Craig, President State University, Missoula, Montana.

J. W. Crockett, Secretary of State, Little Rock, Arkansas.

Melville Dewey, State Librarian, Albany, New York.

T. Duffield, Secretary for Mines, Adelaide, South Australia.

J. A. Ferguson, Commissioner of Agriculture, Labor and Industry, Helena, Montana.

Geological Commission of Finland, Helsingfors, Finland.

J. W. Gregory, Director Geological Survey, Melbourne, Victoria.

H. Gregory, Minister for Mines, Perth, West Australia.

Eugene Haanel, Provisional Superintendent of Mines, Ottawa, Ontario, Canada.

J. H. Hamilton, President Agricultural College, Bozeman, Mont.

G. D. Harris, State Geologist, Baton Rouge, Louisiana.

Erasmus Haworth, State Geologist, Lawrence, Kansas.

G. Henriksen, Government Inspector of Mines, Christiania, Norway.

J. A. Holmes, State Geologist, Chapel Hill, North Carolina.

Mrs. Laura E. Howey, Secretary Historical Society, Helena, Montana.

F. A. Jones, Exposition Commissioner, Santa Fe, New Mexico.

Henry B. Kummel, State Geologist, Trenton, New Jersey.

Alfred C. Lane, State Geologist, Lansing, Michigan.

W. N. Logan, State Geologist, Agricultural College, Mississippi.

A. Gibb Maitland, Government Geologist, Perth, West Australia.

Richard McBride, Minister for Mines, Victoria, British Columbia.

D. McLeod, Minister for Mines, Melbourne, Victoria.

John X. Merriman, Chairman Geological Survey, Cape Town, South Africa.

A Michel-Levy, Director Geological Survey, Paris, France.

W. G. Miller, Provincial Geologist, Toronto, Ontario, Canada.

J. Obalski, Inspector of Mines, Quebec, Quebec, Canada.

- Edward Orton, Jr., State Geologist, Columbus, Ohio.
 George H. Perkins, State Geologist, Burlington, Vermont.
 W. B. Phillips, Director Mineral Survey, Austin, Texas.
 William N. Rice, Superintendent Geological Survey, Hartford, Connecticut.
 A. W. Rogers, Director Geological Survey, Cape Town, South Africa.
 John P. Schmidt, Register of Land Office, Helena, Montana.
 F. J. V. Skiff, Director Field Columbian Museum, Chicago, Illinois.
 Eugene A. Smith, State Geologist, University, Alabama.
 O. F. Stafford, Professor of Chemistry, Eugene Oregon.
 H. H. Swain, President State Normal School, Dillon, Montana.
 J. J. H. Teall, Director Geological Survey, London, England.
 W. H. Twelvetrees, Government Geologist, Hobart, Tasmania.
 John S. Wade, State Engineer, Helena, Montana.
 W. H. Wallace, Secretary of Mines, Hobart, Tasmania.
 Thomas L. Watson, State Geologist, Blacksburg, Virginia.
 I. C. White, State Geologist, Morgantown, West Virginia.
 F. A. Wilder, State Geologist, Iowa City, Iowa.
 W. S. Yeates, State Geologist, Atlanta, Georgia.
 A. J. Yungbluth, Secretary Lake Superior Institute, Mining Engineers, Ishpeming, Michigan.
-

DONATIONS TO THE MUSEUM.

- H. V. Winchell, Butte, Montana—Chalcopyrite in copper glance from Leonard mine, Butte, Montana; copper glance crystal coated with drusey enargite from Butte, Montana; native copper in jasper from Indian Queen mine, Apex, Montana; pseudomorph of limonite after calcite (?) from Lookout mine, Esmerelda county, Nevada.
 A. C. Mason, Helena, Montana—Visible gold in quartz vein in granite from Big Indian mine, Montana.
 H. W. Richards, Butte, Montana—Stephanite from Goldsmith mine, Butte, Montana.
 U. F. Hughes, Princeton, Montana—Sample of rutile and ilmenite from Gold Creek, Montana.
 James R. Thmopson, Butte, Montana—Sample of cuprite copper ore from mines of Nevada Consolidated Company, Ely, Nevada.
 E. C. Woodward, Wisdom, Montana—Sample of gypsum from Jefferson county, Montana.
 John P. O'Neill, Butte, Montana—Sample of wood from old mine timber from Anaconda mine, Butte, showing deposition of native copper by action of carbon on copper sulphate in solution in mine waters.
 C. S. Jackman, Butte, Montana—Sample of slickensides from the Gagnon mine, Butte, showing curved motion.
 John McGee, Kendall, Montana—Sample of cerargyrite from Eldorado Canon, Nevada.
 P. C. Dean, Butte, Montana—Sample of chrysocolla from the Bertha mine near Columbia Gardens, Montana.

DONATIONS TO THE MUSEUM FROM MONTANA MINERAL
EXHIBIT.

Thomas Long, Philipsburg, Montana—Powder thawer.

H. J. Humphries, Nelson, Nevada—Ores from Big Four group, Jefferson county.

Florence Manufacturing Company, West Sulphur Springs—Ores from Florence mine, Neihart, Cascade county.

John Nesbit, Castle, Montana—Ores from Nesbit mine, Meagher county.

Speculator Mining Company, Butte, Montana—Ores from Speculator mine, Butte, Silver Bow county.

Ingersoll Mining Company, Neihart, Montana—Ores from Ingersoll mines, Neihart.

Leviathan Gold Mining Company, Mammoth, Montana—Ores from Mammoth mines, Mammoth.

Bald Butte Mining Company, Helena, Montana—Ores from Bald Butte mine, Lewis and Clarke county.

Morris Estate Pony, Montana—Ores from Clipper and Boss Tweed mines, Pony, Montana.

Louis Girard, Paris, France—Ores from Lexington mine, Butte, Montana.

Montana Revenue Gold Mining Company, Norris, Montana—Ores from Monitor mine, Norris.

Boston & Montana C. C. & S. M. Co., Butte, Montana—Extensive series of products of B. & M. smelter at Great Falls, also ores from B. & M. mines, Butte.

Amalgamated Copper Company, Butte, Montana—Ores from Anaconda, Parrot, Gagnon and other mines, Butte.

Washoe Copper Company, Anaconda, Montana—Extensive set of products of Washoe smelter, Anaconda.

Alice Gold and Silver Mining Company, Walkerville, Montana—Ores from Alice mine, Walkerville, Montana.

J. H. Longmaid, Helena, Montana—Ores from Belmont mine, Marysville, Montana.

Toledo Power & Mining Company, Chicago, Illinois—Ores from Toledo mine, Sheridan, Montana.

C. W. Ellingwood, Butte, Montana—Ores from Goldsmith mine, Butte, Montana.

L. H. Faust, Libby, Montana—Ores from Mollie Gibson mine, Libby, Montana.

B. H. Tatem, Helena, Montana—Ores from Lee Mountain mine, Rimini.

Hecla Consolidated Mining Company, Melrose, Montana—Ores from Hecla mines.

Thomas Haw, Dillon, Montana—Grey copper from Beaverhead county.

Hugh Elliott, Norris, Montana—Ores from Lehigh mine, Norris, Montana.

Senator W. A. Clark, Butte, Montana—Ores from Steward and Original mines; extensive set of products of Butte Reduction Works,

Butte; model of Never Sweat-Colusa Parrot mines, Butte; model of Parrot ore sizer.

A. H. Wethey, Butte, Montana—Model of Wethey calcine furnace.

Moffit Bros., Melrose, Montana—Ores from Quincy mines, Madison county.

Harper & MacDonald, Butte, Montana—Maps of Butte.

Montana Mining Company, Limited, Marysville, Montana—Ores from Drum Lummon mines, Marysville, Montana.

John R. Quigley, Ophir, Montana—Ore from Molybdenite mine, Ophir.

Mrs. John Keating, Helena, Montana—Ores from Ohio mine, Radersburg.

Mitchell & Mussigbrod, Garnet, Montana—Ores from First Chance mines, Garnet.

A. M. Holter, Helena, Montana—Ores.

Dr. G. E. Blackburn, Butte, Montana—Ores from Arnold mine, Powell County.

Cottonwood Coal Co., Stockett, Montana—Assorted sizes of coal and blueprints of coal washery.

Pearl I. Smith, Dillon, Montana—Graphite ore and crucible made from same.

Thos. Cruse, Helena, Montana—Ores from Jackson mine, L. & C. Co.

H. L. Frank, Butte, Montana—Samples of sandstone from Columbus, Montana.

Northwest Improvement Co., Red Lodge, Montana—Samples of coal.

DONATIONS TO DEPARTMENT OF MINING ENGINEERING.

There have been donated, or loaned, for exhibition purposes, to the School the following in this department:

Samples of punched plate screens, cut from regular sheets and about 8 inches by 8 inches in size. From the Allis-Chambers Co., Chicago.

Handsomely mounted samples of wire cloth screens from The W. S. Tyler Co., Cleveland. Secured through the courtesy of The Allis-Chalmers Co.

Pamphlets descriptive of crushing and concentrating machinery from The Power and Mining Machinery Co., of Cudahy, Wis., and from Mr. R. K. Humphrey.

Mr. Humphrey also gave an illustrated talk on the subject of roll crushing to the students in ore dressing.

One Little Wonder Air Feed Drill (Hardscog) with arm, clamp and bit, from The Western Mining Supply Co., Butte.

One hundred copies of a collection of professional papers, read before the Black Hills Mining Men's Association. Donated through Mr. J. V. N. Dorr, Terry, S. D.

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions are made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense, to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter; the opportunity is here presented for daily observation of works whose development and whose product have given to the City of Butte the reputation of being the greatest mining center in the world.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them; but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place, permission is given to the mining classes to witness the same, under the guidance of their instructors.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

In addition to these comparatively short excursions, the Freshmen spend six weeks of their summer vacation time in camp, where they are given fifty hours per week in learning the use of instruments, and in such exercises as are detailed on pages 36-7. The Juniors, in like manner, spend six weeks of their summer vacation in underground surveys, in the mines, under the direction of the Professor in charge of Mining Engineering, and in map drawing to show underground workings. In like manner the Junior class spends four weeks making Geological Surveys in some one of the interesting Geological fields of this state and adjoining states.

EXCURSIONS OF 1905-6.

The following is a list of the formal excursions that have been made during the year 1905-6:

METALLURGICAL EXCURSIONS.

SENIOR CLASS.—Metallurgical trip to the East Helena Lead smelter, East Helena, Montana, and U. S. Assay Office, Helena, Montana, January 16th to 20th, 1906.

JUNIOR CLASS.—Metallurgical trip to Washoe Copper smelter, Anaconda, Montana, January 22d to 27th, 1906.

GEOLOGICAL EXCURSIONS—JUNIOR CLASS.

To the Indian Queen mine, near Apex, Beaverhead Co., Montana, February 1-4, 1906.

To the Goldsmith mine, Butte, Feb. 9, 1906.

To the Combination mine, Butte, Feb. 16, 1906.

To the Goldsmith mine, Butte, Feb. 23, 1906.

To the Goldsmith mine, Butte, March 2, 1906.

To the Goldsmith mine, Butte, March 9, 1906.

To the High Ore mine, Butte, March 23, 1906.

To the Silver Bow mine, Butte, March 30, 1906.

EXPENSES

FEES.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who only attend for part of the semester.

DEPOSITS.

To secure the State against loss for apparatus that may be broken or damaged by the student, a deposit is required at the beginning of the year from each one engaged in laboratory work.

This deposit is placed in the hands of the Treasurer of the Board of Trustees. Each student is charged with the apparatus issued to him. At the close of the year he is credited with such articles as he returns in good order. The balance of this account is then returned to him.

The following is the list of deposits that are required:

FRESHMAN YEAR.

General Chemistry and Qualitative Analysis.	\$15.00
Surveying	10.00

SOPHOMORE YEAR.

Quantitative Analysis	\$15.00
Mineralogy	10.00

JUNIOR YEAR.

Metallurgy and Assaying	\$10.00
Mine Surveying	10.00

SENIOR YEAR.

Petrography	\$10.00
Metallurgy	10.00

When the breakage exceeds the deposit the student will be required to make good the full amount of the damage done.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in the City of Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the far West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. For those who find it necessary to economize, there are few cities that afford as favorable opportunities for self-help as are found here.

GENERAL INFORMATION

It is no longer necessary to call attention to the fact that the City of Butte is one of the greatest mining centers of the world. The discoveries and developments of the past year, and the enormous investment of capital in the mines of this city by the leading financiers and mining men of this country and Europe have given to this locality such publicity that no one now needs to be told of its leading position in the mining world.

Following a long period in which its mineral product though larger than that of any other field, was kept far below its capacity by reason of conflict of titles to mining ground, a settlement has been effected which will permanently remove all such restriction in its output. New life has been infused, new mines located, and such aggregations of capital have been enlisted, as promise a vast increase in its production for a generation to come. With this increase in production, there has come a largely increased demand for copper, and a consequent advance in prices, that must for some years to come make the mining of the red metal in Butte one of the most profitable industries of the world.

The great reduction plants that have heretofore handled the ore that comes from the mines of this city must be enlarged to treat the enlarged product. The modern devices for reducing the expense of treatment will be developed on a larger scale, and all of this increase in every department of the mining industry goes to render this place the more desirable as a location for a Mining School.

In a very important sense all these mining plants of every description are a part of the substantial equipment of the School, because its pupils are brought into daily contact with the men who are personally engaged in the various departments of this industry and are thoroughly conversant with all the details of the work.

Through the courtesy of the great mining companies, as well as the smaller operators, and individual miners, the students of the School of Mines have every proper opportunity of visiting these mining plants and observing the operations therein conducted.

The great practical advantage that thus accrues to the mining student cannot be over estimated.

CATALOGUE OF STUDENTS, 1905-6**LIST OF STUDENTS.****RESIDENT GRADUATES.**

P. L. Pauly Kendall, Montana

SENIOR CLASS.

Dugan, John F. Butte, Montana
Feeney, Chas. W. Butte, Montana
Geiser, Herbert S. Butte, Montana
Johns, John W. Butte, Montana
Kane, Louis M. Butte, Montana
Warfield, Herschel J. Butte, Montana
Wilson, T. Bert Butte, Montana
Young, Siegfried A. Astoria, Oregon
Young, Arthur B. Astoria, Oregon

JUNIOR CLASS.

Adami, Arthur E. Helena, Montana
Bovett, Clifford J. Butte, Montana
Clingan, Huett S. Belt, Montana
McCrackin, Ralston H. Butte, Montana
Meiklejohn, Archie B. Butte, Montana
Reardon, Daniel Butte, Montana
Shaffer, Wm. A. Glen Falls, N. Y.
Villars, Jesse R. Arkansas City, Kansas

SOPHOMORE CLASS.

Bowden, Malcolm Helena, Montana
Brulo, William. Helena, Montana
Ellis, Willis H. Butte, Montana
Foote, Frank A. Butte, Montana

Harlan, Clyde C.	Kansas City, Missouri
Heimerdinger, Harry B.	Butte, Montana
Hoffman, David A.	Great Falls, Montana
Ketcham, Samuel H.	Clinton, Montana
Lomas, Percy	Butte, Montana
Lowrie, Thomas M.	Butte, Montana
McLaughlin, Wm. H.	Butte, Montana
O'Brien, Albert	Butte, Montana
Proctor, Israel O.	Great Falls, Montana
Proctor, Merton D.	Great Falls, Montana
Patten, Earle	Philipsburg, Montana
Schiffner, Otto E.	Minneapolis, Minnesota
Sengbusch, Lawrence W.	Great Falls, Montana
Walton, Lee M.	Butte, Montana

FRESHMAN CLASS.

Baker, Jacob H.	Butte, Montana
Brazier, Walter T.	Butte, Montana
Corr, Frank R.	Butte, Montana
Doane, C. F.	New York City, N. Y.
Dubie, Edward	Butte, Montana
Evans, James	Butte, Montana
Haines, Peter	Butte, Montana
Harris, Frank C.	Butte, Montana
Johnstone, J. Clark	Butte, Montana
Kane, Edward	Butte, Montana
Loughran, Michael	Butte, Montana
Malloy, Edward E.	Butte, Montana
Moore, Frederick N.	Butte, Montana
Peters, Ira B.	Butte, Montana
Stockett, Norman H.	Bankhead, Alberta, N. W. Terr.
Wiegenstein, Henry J.	Philipsburg, Montana
Williams, Daniel J.	Kalispell, Montana

SPECIAL STUDENTS.

Clark, Joseph R.	Butte, Montana
Chemistry and Qualitative Analysis.	
Coates, Calvert	Butte, Montana
Metallurgy and Assaying.	
Cornelius, Benj. J.	Butte, Montana
Chemistry, Metallurgy and Mineralogy.	
Green, T. S.	Butte, Montana
Field Surveying.	
Kirby, Kenneth P.	Butte, Montana
Metallurgy and Mathematics.	
Kyle, Robert G.	Butte, Montana
Quantitative Analysis, Assaying and Metallurgy.	
McCaw, Patrick	Butte, Montana
Surveying and Mathematics.	
Ryan, D. B.	Butte, Montana
Mechanical Draughting.	

SUMMARY.

Resident Graduates	1
Seniors	9
Juniors	8
Sophomores	18
Freshmen	17
Special Students	8
Total	61

REGISTER OF THE ALUMNI BY CLASSES

1903.

Louis V. Bender 404 E 3rd St., Anaconda, Montana
Chemist, Anaconda C. M. Co.

1904.

Alfred J. Balmforth Paradise, Arizona
Mining Engineer.

Clara Clark.....Butte, Montana

J. Fred Duling Tonapah, Nevada
With Harper & MacDonald, Mining Engineers.

Arthur J. Irelan Helena, Montana
Mining Engineer.

Henry E. Kuphal Los Angeles, Cal.
Mining Engineer.

Isabel (Little) Stevenson.....Sumpter, Oregon

Lachlan D. MacRae Argenta, Montana
Manager Butte-Argenta Mining Co.

John McGee Kendall, Montana
Sup't Barnes-King Mining Co.

P. L. Pauly Kendall, Montana
Foreman Barnes-King Mining Co.

H. S. Tallant Butte, Montana
Sampler and Time Keeper East Colusa Mine.

CLASS—1905.

- Geo. Archibald Butte, Montana
Eng. Dep't A. C. M. Co.
- O. F. Brinton Butte, Montana
Mining Engineer.
- Clarence R. Corey Sumpter, Oregon
With W. W. Elmer, Consulting Engineer.
- John M. Duthie Butte, Montana
Assistant City Engineer.
- Basil Elford Tonopah, Nevada
Mining Engineer.
- Louis C. Mackel Cable, Montana
Southern Cross Gold Mining Co.
- Paul D. Pratt Butte, Montana
Eng. Dep't M. O. P. Co.
- Leon C. Stevenson Sumpter, Oregon
With W. W. Elmer, Consulting Engineer.
- Jay Van Gundy Orogrande, Idaho
Assayer Crooked River Mining Co.

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THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

CATALOGUE
OF THE
MONTANA STATE
SCHOOL OF MINES

BUTTE, MONTANA

1906-1907

MONTANA STATE
SCHOOL OF MINES
BUTTE, MONTANA

SEVENTH ANNUAL CATALOGUE
OF OFFICERS AND STUDENTS
FOR THE YEAR
1906-1907

WITH ANNOUNCEMENTS FOR THE YEAR
1907-1908

CALENDAR FOR 1907-1908.

1907

August 30 and 31, Entrance and Special Examinations.

September 3, First Semester begins.

October 25, Close of First Term, First Semester.

October 28, Second Term, First Semester begins.

November 28, Thanksgiving Day.

December 20, End of First Semester.

1908

January 6, Second Semester begins.

February 22, Washington's Birthday.

March 13, close of First Term, Second Semester.

March 16, Second Term, Second Semester begins.

May 29, Commencement Day.

June 1 to July 11, Mine Surveying, Sophomores.

July 13 to August 22, Field Work in Geology, Juniors.

July 13 to August 22, Field Work in Surveying, Freshmen.

September 1, First Semester begins.

CALENDAR.

1907							1908														1909						
JULY							JANUARY							JULY							JANUARY						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
.....	1	2	3	4	5	6				1	2	3	4				1	2	3	4					1	2	
7	8	9	10	11	12	13	5	6	7	8	9	10	11	5	6	7	8	9	10	11	12	13	14	15	16	17	18
14	15	16	17	18	19	20	12	13	14	15	16	17	18	12	13	14	15	16	17	18	19	20	21	22	23	24	25
21	22	23	24	25	26	27	19	20	21	22	23	24	25	19	20	21	22	23	24	25	26	27	28	29	30	31	
28	29	30	31				26	27	28	29	30	31		26	27	28	29	30	31								
AUGUST							FEBRUARY							AUGUST							FEBRUARY						
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BOARDS OF CONTROL.

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Term Expires 1910

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C. R. LEONARD, Butte

Term Expires 1909

G. T. PAUL, Dillon

C. N. KESSLER, Helena

Term Expires 1908

O. P. CHISHOLM, Bozeman

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JOSEPH ROBERT,
Janitor.

MONTANA STATE SCHOOL OF MINES.

HISTORICAL SKETCH.

The "Enabling Act," which paved the way for the admission of Montana into the Union as a State, contained a provision for a donation of public land for the establishment and maintenance of a state school of mines. The grant provided one hundred thousand acres to be sold at not less than ten dollars per acre, thus insuring ultimately a fund of one million dollars. The date of this act was February 22, 1889. It was a significant date, and it marks the first national provision for education in the interest of the mining industry. This legislation was the natural sequel to the Morrill Act of 1862, which provided for the establishment and maintenance of state colleges for education in agriculture and the mechanic arts. Mining and agriculture stand pre-eminent as factors in the development of the resources of the country and the growth of the nation in wealth and power. It was an enlightened statesmanship that dictated these two systems of education as the best means to secure the best interests of the entire people.

The first Legislative Assembly of the State appointed commissioners to select these lands. They are located mainly in the northwest quarter of the State, and for this reason are not yet salable at the minimum price fixed by Congress, but the prospective increase of immigration following the development of the extensive system of irrigation planned

for our State will soon place some of these lands above the minimum value.

ORGANIZATION.

By legislative enactment the Montana School of Mines was located at Butte, the great mining center of the State. Certain public spirited citizens of the city donated a plat of ground 376 feet by 500 feet as a building site for the School. This plat is on the southern bench of "Big Butte," the extinct volcano from which the city takes its name. It is within the limits of the city, and only a few blocks from one of the street car lines. It commands a fine view of the city, the mines, and the smelters, as well as of the great continental divide, which bounds the horizon on the east and south.

In 1895 a Building Commission was appointed, and authorized by the legislature to issue bonds, the proceeds of which were to be used for the erection of a suitable building for the School. The building was erected during the years 1896 and 1897 through the use of funds advanced by citizens of Butte, who were repaid in full when the bonds were finally issued in 1900. The bonds issued amount to \$120,000, bearing five per cent interest, and maturing in thirty years, but payable at the option of the State in fifteen years.

The School of Mines building is of brick with stone foundations and trimmings. It has three stories above the basement, including the top floor, which is furnished with skylights as well as windows for illumination. It faces toward the city, that is, toward the east. The length along the front is 118 feet, and the depth is 94 feet. It contains 37,000 square feet of available floor space, and in construction fireproof material was used to a large extent.

In the basement the flooring of the halls and of some of the rooms is of cement; elsewhere on this floor pine floors are used. The largest room in the basement is the chemical laboratory, which is 32 by 47 feet; there are four rooms each 23 by 31 feet—they are the furnace room, the engine room, the office of the professor of chemistry, and the assay laboratory. The pulp room, containing gas assay furnaces, is 12 by 24 feet. The metallurgical laboratory is 31 feet square. The office of the assistant professor of chemistry is 9 by 19 feet. The balance room is 18 by 31 feet, while the chemical supply room is 19 by 21 feet, and the rock crushing room 19 by 27 feet.

On the first floor there are two rooms each 31 feet square, viz., the museum and the chemical lecture room; two rooms, each 24 by 31 feet, viz., the mathematics lecture room and the mechanics lecture room; and two rooms, each 14 by 19 feet, viz., the faculty room and the President's office. The physical laboratory is 23 feet square, while the office of the professor is 8 by 23 feet. The library is 23 by 31 feet. The main halls, which are floored with tiling, are 8 feet wide and 114 feet long on each story. The main stairway occupies 20 by 24 feet.

On the second floor there are two rooms, each 31 feet square, viz., the sophomore drawing room and the mineralogical laboratory; two rooms, each 24 by 31 feet, viz., the mining lecture room and the geology lecture room. The office of the professor of mining is 23 by 31 feet; that of the professor of geology is 23 feet square. The front room on this floor is 14 by 50 feet.

On the third floor the petrographic laboratory is 31 feet square; it has been especially arranged to secure abundant light from the north. The mineral

storage room is 19 by 24 feet, the dark room is 9 by 14 feet, and the petrographic lathe room is 20 by 24 feet. The freshman drawing room on this floor is 31 by 65 feet; the general storage room is 25 by 115 feet.

The building is heated by steam, and lighted by gas and electricity. It is finished inside in oak polished in the natural colors; the furnishings are largely finished in golden oak.

The maintenance of the School is provided by the State through biennial appropriations made by the Legislative Assembly. The sum provided by the Assembly of 1907 was \$30,480 per year for the biennium ending February 28, 1909. The same Assembly appropriated \$14,000 for a new boiler and power plant at the School of Mines, and a further sum of \$45,000 for a metallurgical laboratory building. These buildings will be erected as soon as plans for them are matured.

The control of the entire system of public education in the State is vested by the Constitution of Montana in the State Board of Education. This Board consists of the Governor of the State, the Attorney General, and the State Superintendent of Public Instruction, together with eight other members who are appointed by the Governor and confirmed by the Senate. The appointive members hold office for four years.

The legislative act establishing the Montana School of Mines provided for a Board of Trustees to be chosen by the State Board of Education. To the Board of Trustees is committed the immediate supervision of the School, the adoption of a course of study, and the election of the officers and members of the faculty; but all the acts of this body are sub-

ject to the approval of the Board of Education. The Trustees hold office for a term of four years.

The aim of the Montana State School of Mines is to furnish the best possible education to those whose life work will be devoted to mining in any of its branches. The School is therefore wholly a technical one, not providing an education for the business man, the farmer, or the literary man, but confining its energies wholly to the proper mental equipment of mining men. The course of study, which is fully described in the following pages, has been elaborated with this purpose constantly in mind. Those who complete this course will receive the degree of Engineer of Mines.

REQUIREMENTS FOR ADMISSION.

The Montana State School of Mines is open to residents of Montana and to residents of other states and countries regardless of sex or race, on terms prescribed by the Board of Trustees; provided they are qualified to pursue the studies enumerated on the following pages.

Applicants for admission to the Freshman Class must be prepared to pass a satisfactory examination in the following subjects:

English composition, reading, and spelling.

Arithmetic, including the metric system.

Algebra, as much as is covered by the first 23 chapters in Wentworth's Higher Algebra.

Geometry; plane, solid and spherical.

Geography, political and commercial.

Geography, physical.

Physiology or elementary zoology.

Special stress will be laid on the applicant's proficiency in English composition, reading, and spelling. A marked lack of ability in this subject will bar the

applicant from admission, though his proficiency in other subjects may be satisfactory.

Graduates from the accredited high schools of the State of Montana and graduates from accepted high schools in other states will be admitted without examination, on presentation of their diplomas, provided the course of study pursued includes the above topics required for admission to the Montana State School of Mines.

Graduates from such schools should present with their diplomas a description of the course of study which they pursued and from which they graduated, certified to by the principal of said school.

LIST OF ACCREDITED HIGH SCHOOLS IN THE STATE OF
MONTANA.

County High Schools.

Beaverhead	Granite
Broadwater	Jefferson
Carbon	Park
Custer	Powell
Fergus	Sweet Grass
Flathead	Teton.
Gallatin	

City High Schools.

Anaconda	Glendive
Billings	Great Falls
Butte	Hamilton
Forsythe	Helena
Fort Benton	Missoula.

Graduates from the Stevensville Training School will be admitted on the same terms as those from the accepted high schools of Montana.

It is the opinion of the faculty of the Montana School of Mines that candidates for admission to this school should have taken at least a full high school course or an equivalent course in some other school.

Applicants for admission to the sophomore, junior, or senior classes must pass a satisfactory examination in all the studies required in the class or classes preceding the one they desire to enter. Credit will be given for work done in other institutions of recognized rank, provided the candidate can furnish satisfactory proof of having received a passing mark in such institution before leaving.

The Faculty reserves the right to examine any and every student applying for admission, notwithstanding he may have credits for work done or may be in possession of a diploma from an accredited high school or other school of equivalent rank.

Persons of mature years, who are not candidates for a degree, may be admitted without examination to any of the studies they may select, on giving satisfactory evidence of their preparation to pursue the particular study with profit to themselves and without embarrassment to the class.

COURSE OF STUDY.

FRESHMAN YEAR.

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Higher Algebra.....	4.....	4.....
Trigonometry	5.....	5.....
Chemistry, Lectures	3.....	3.....
Chemistry, Laboratory.....	6.....	6.....
English	3.....	3.....
Mechanical Drawing.....	9.....	9.....

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Analytical Geometry.....	5.....	5.....
Chemistry, Lectures.....	3.....	3.....
Chemistry, Laboratory.....	9.....	9.....
English	3.....	3.....
Surveying	4.....	4.....
Mechanical Drawing.....	6.....	6.....

Surveying, summer course of six weeks.

SOPHOMORE YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Calculus	5.....	5
Physics	5.....	5
Chemistry, Lectures	1.....	1
Chemistry, Laboratory.....	12.....	12
Mineralogy	4.....	4
Mineralogy, Laboratory.....	3.....	3

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Calculus	5.....	3
Physics	5.....	7
Chemistry	6.....	6
Mineralogy, Descriptive.....	2.....	2
Mineralogy, Determinative.....	4.....	4
Mine Surveying.....	2.....	2
Topographical Drawing.....	6.....	6

Mine Surveying, summer course of six weeks.

JUNIOR YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mechanics	5	5
Machine Design	2	2
Geology, Physical.....	5	5
Metallurgy, Assaying	12	0
Metallurgy, Copper	3	3
Gas Analysis	0	3
Testing Laboratory.....	3	3
Drawing, Mapping.....	0	3
Drawing, Designing.....	0	9

Metallurgical excursion to copper smelter, one week.

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Geology, Historical.....	2	2
Geology, Economic	3	3
Mechanics of Materials.....	3	3
Hydraulics	2	2
Mining	2	2
Metallurgy, Gold and Silver.....	3	3
Metallurgy, Laboratory	3	3
Geological Excursion	3	3
Drawing, Designing.....	6	6

Mining and metallurgical excursion, 2 weeks.

Field Geology, summer course of six weeks.

SENIOR YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mechanical Engineering of		
Power Plants.....	3.....	3
Graphical Statics.....	9.....	0
Mining	0.....	2
Ore Dressing, Lectures	0.....	5
Metallurgy of Lead	3.....	6
Engineering Design.....	0.....	6
Petrography.....	2.....	2
Petrography, Laboratory.....	9.....	6
Metallurgical excursion to lead smelter, 1 week.		

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mining Engineering.....	3.....	3
Ore Dressing	3.....	3
Metallurgy	3.....	3
Metallurgy, Laboratory.....	3.....	3
Mechanical Engineering of		
Power Plants.....	3.....	3
Electrometallurgy.....	6.....	0
Engineering Design.....	3.....	9
Engineering Construction	2.....	2

ENGLISH

MR. KIRK

English Composition.—This is a course in the principles and practice of English composition. Lectures are given on the whole composition, paragraph and sentence; weekly themes and daily paragraphs are required; notes are taken on assigned readings. The work is intended to supplement the usual high school courses in literature. Instead of dealing with figures of speech and other rhetorical devices, however, it has to do more with the outline, and unity, coherence and emphasis, as applied to exposition and argumentation.

Freshman, first semester, three hours per week.

English—Technical Prose.—This is a continuation of the first course. Studies are made in the structure of modern prose; critiques and model paragraphs are written; lectures are given on words. Training in business correspondence is also given, and special studies made in technical vocabulary.

Freshman, second semester, three hours per week.

MATHEMATICS

PROFESSOR CRAVEN, PROFESSOR BOWMAN

Algebra.—A short preliminary course is first given, designed to drill the student in the fundamental operations and in the statement and solution of problems. The following topics constitute the chief items for the term's work: Indeterminate coefficients; theory and use of logarithms; limits; introduction to derivatives; binomial and logarithmic series; tests of convergency of series; general theory of equations; solution of numerical equations. The text book used is Wentworth's Higher Algebra.

Freshman, first semester, four hours per week.

Trigonometry.—In plane trigonometry the subjects of primary importance are: goniometry; solutions of right and oblique triangles; practical problems. The solution of the right and oblique angled spherical triangles is developed and practical application is made to surveying and mensuration. The text book used is Wentworth's Plane and Spherical Trigonometry.

Freshman, first semester, five hours per week.

Analytical Geometry.—In this course a systematic study is made of the following: the point and straight line in a plane; different systems of coordinates; conic sections; discussion of the general equation of the second degree with two variables; higher plane curves; the point and straight line in space; curved surfaces and surfaces of revolution. The text used is Wentworth's Analytic Geometry.

Freshman, second semester, five hours per week.

Calculus.—Among the topics studied in this course may be mentioned: Differentiations, Taylor's theorem; indeterminate forms; maximum and minimum; tangents, normals,

and asymptotes; curvature and radius of curvature; integration; rectification of curves; areas; volumes; center of mass; moment of inertia. Application is made to numerous problems in mechanics during the latter part of lectures. The text being presented in the form of lectures. The text book used is Differential and Integral Calculus, by Taylor.

Sophomore, throughout the year, five hours per week.

GEOLOGY AND MINERALOGY

PROFESSOR WINCHELL AND MR. KIRK

Crystallography.—The course embraces a study of the internal structure of crystals and its relation to their external form, of the symmetry elements, and the various kinds of symmetry possible in the internal molecular arrangement of crystals. It includes, further, a study of the external forms of crystals, the symmetry of these forms, and their classification into the thirty-two symmetry groups and six crystal systems. By the constant use of models and natural crystals the student is expected to become familiar with all the simpler forms. The most important methods of notation of crystal faces, and of the measurement of the angles between them, as well as their mathematical relations, receive attention. Finally, the course includes a study of crystal aggregates, including twins, of irregularities in crystals, of crystalline aggregates, of pseudomorphs, and of methods of drawing crystals. The course is presented by means of lectures, and Dana's text book of Mineralogy is used in connection therewith.

Sophomore, first semester, first term, four hours per week.

Physical and Chemical Mineralogy.—The course in physical mineralogy embraces a study of those characters of minerals which depend upon cohesion, elasticity, mass, light, heat, electricity, magnetism, and the action of the senses. Particular stress will be laid upon such characters as cleavage, hardness, specific gravity, diaphaneity, color, luster, and fusibility, which will aid the student in the determination of minerals. The instruction in chemical mineralogy treats of the general principles of chemistry as applied to minerals, and of the use of the blowpipe and accompanying reagents. It includes also a discussion of isomorphism, dimorphism, and the genesis of pseudomorphs. These subjects are presented in lectures. The students use Dana's Text Book of Mineralogy.

Sophomore, first semester, second term, four hours per week.

Mineral Laboratory Methods.—In this work the student becomes familiar with the use of physical apparatus as applied to minerals, and the actual manifestation of the blowpipe. The more important and rapid chemical reactions are employed in tests upon known minerals; but the physical characters, especially specific gravity, hardness, luster, color, and crystallization, as well as association and occurrence,

are studied carefully. Text book: Crosby's Tables for the Determination of Minerals.

Sophomore, first semester, three hours per week.

Descriptive Mineralogy.—The course treats of the physical and chemical properties of minerals, their occurrence, association, classification, and uses. The object in view is to give the student a practical knowledge of the characters, uses, and occurrence of the commoner minerals. The subject is presented by means of lectures and notes, with Dana's Text Book of Mineralogy as a reference work.

Sophomore, second semester, two hours per week.

Determinative Mineralogy.—This course is wholly laboratory work and presupposes the course in mineral laboratory methods. The student is given actual practice in the determination of minerals unknown to him by their chemical and physical characters. He is expected to become sufficiently familiar with the common and important minerals to be able not only to recognize them readily, but to give their composition, occurrence, and associations. Text book: Crosby's Tables for the Determination of Minerals, with frequent references to Dana's System of Mineralogy and other library works.

Sophomore, second semester, four hours per week.

Physical Geology.—This course treats of the origin of rocks, the interior condition of the earth, volcanic and earthquake action, mountain building, faulting, jointing, metamorphism, and the altering actions of air, water, and life. Much stress is laid upon the relation of these conditions to the problems of the mining engineer, the economic geologist, and the quarryman. Texts: Scott's Introduction to Geology and Kemp's Handbook of Rocks.

Junior, first semester, five hours per week.

Historical Geology.—The chief aim in this work is to acquaint the student with the lithologic history of the earth and with the value of fossils in determining modes of formation, order of superposition, and growths of continents. The periods of crustal disturbance and their effects upon vein systems and bedding structures are studied closely, and the more important economic horizons have especial attention called to them. Charts, maps, geologic atlases, and Chamberlin and Salisbury's Earth History are referred to extensively. Text: Scott's Introduction to Geology.

Junior, second semester, two hours per week.

Economic Geology.—In this course the uses and commercial value of mineral products are especially emphasized. The course includes a study of the common rock and vein-forming minerals, the origin of ore deposits, the classification of ore deposits, the uses, occurrence, geological and geographical distribution and production of iron, copper, gold, silver, lead, zinc, etc., as well as of coal, petroleum, building stones, soils, clays, fertilizers, artesian wells, salt, abrasive materials, precious stones, etc. In connection with

this course geological excursions take the class to the various mines of Butte, and to others of different character outside the city. These excursions occupy one afternoon per week during one term, and laboratory work in geological mine mapping, and the construction of sections and diagrams, occupies the same time during another term. The text book used is Ries' Economic Geology.

Junior, second semester, six hours per week.

Field Geology.—Study of a selected area in the vicinity of Butte. Practice in observing geological features and in interpreting them. Geological mapping.

Junior, summer course of six weeks.

Petrography.—This course is introduced by a review of the principles of optics, including the propagation of light, total reflection, refraction, polarization, and dispersion. The student must become familiar with the theory and use of the simple and compound microscope, the mica and gypsum plates, the quartz wedge, the Bertrand lens and the camera lucida. He must also become acquainted with the method of preparation of thin sections by means of rock cutting and grinding machines. In order to properly determine minerals with the microscope the student must study their crystal form and habit, cleavage and parting, color and pleochroism, refringence and birefringence, positive or negative character, and uniaxial or biaxial interference figures, and their dispersion. When able to recognize promptly the important rock-forming minerals, the student is prepared for the microscopical study of rocks.

Senior, first semester, first term, eleven hours per week; second term, eight hours per week.

CHEMISTRY

PROFESSOR SCHIERTZ, ASSISTANT PROFESSOR HARTZELL,
MR. COREY

General Chemistry.—The subject of general chemistry is presented through lectures and text books. The object of the course is to develop the underlying principles of chemistry as a basis for all subsequent work in the department. The student is made familiar with the principal characteristics and relations of the elements, the work is also copiously illustrated with experiments conducted by the instructor. It is necessary that the student should take full notes on the lectures, which are designed to aid and direct the laboratory work of the same semester.

Freshman, first semester, three hours per week.

General Chemistry, Laboratory.—The laboratory course in general chemistry consists in performing a large number of experiments by the students at individual desks. Aside from becoming proficient in the use of apparatus, the student becomes familiar with the different acids, bases and salts, their reactions and relations with each other. It is a part of the work to keep a neat notebook in which are recorded

the reactions and statements of the principles involved in each experiment.

Freshman, first semester, six hours per week.

Qualitative Analysis.—The course in qualitative analysis is designed to instruct the students in the general schemes of analysis by which the different metals are detected and separated from each other. The problem of isolating and identifying the acid radicals is also a part of the course. The accompanying lectures give a general outline of the schemes of separation and deal with the merits and difficulties of each, finally pointing out the best method to be used by the mining engineer. The essential element of writing and balancing chemical equations is made a part of the drill work of the class. During the last part of the course the class is introduced to the subject of stoichiometry. The text book used is Prescott and Johnson's Qualitative Analysis.

Freshman, second semester, three classroom hours and nine laboratory hours per week.

Quantitative Analysis.—The course in quantitative analysis embraces a study of such analyses as the mining engineer meets in practicing his profession in the laboratories of smelters and mine plants. The main object in view is to develop the ability in the student to do this work with the accuracy and rapidity required in practice, so that the student who completes the course need have no hesitancy to accept a position of this character.

Among the analyses performed may be mentioned the analysis of limestone, dolomites, feldspars, ores of iron, manganese, lead, zinc, arsenic, copper, etc. Analyses are made of mattes, flue dust, concentrates, calcines, and pig-iron. During the course some time is spent on acidimetry and alkalimetry. The laboratory work is performed by the students at individual desks where the best appliances and modern conveniences are at hand. The classroom work consists of discussions and quizzes on the theory of the laboratory work.

Sophomore, first semester, one hour classroom and twelve hours laboratory work per week; second semester, six hours per week.

METALLURGY

PROFESSOR SCHIERTZ, ASSISTANT PROFESSOR HARTZELL,
MR. COREY

Metallurgy of Copper.—The study of the metallurgy of copper is conducted by lectures and recitations covering the entire subject. The electrolytic refining of copper bullion is studied as a part of this course. Immediately after the subject is treated in the lecture and recitation room, one week is devoted to a practical study of the smelter and electrolytic refinery at Anaconda or at Great Falls. Each operation in the treatment of copper ores is studied in detail, among them may be mentioned the processes of concentration, the production of matte by either the reverberatory or blast furnace,

the blowing of matte to metallic copper in the converter, or the process of refining matte in the reverberatory refining furnace. Nearly all the known methods of concentration, roasting, and reduction of copper ores are studied during these visits. A typewritten report of the operations studied is required of the class.

Junior, first semester, three hours per week.

Assaying.—The subject is presented in the form of lectures, with references to text books. The practical work consists of the fire assaying of gold, silver, and lead in all varieties of crude ores and smelter products, such as copper and lead slags, copper and lead mattes, copper and lead bullion, lead dross and speiss, calcines, flue dust, tailings, the muffle assay of coals, etc.

The laboratory is fitted with the most modern appliances and it is a part of the aim of the course to give the student a thorough drill in accuracy and rapidity.

Junior, first semester, first term, twelve hours per week.

Metallurgy of Gold and Silver.—The second semester of the Junior year is devoted to the study of the metallurgy of gold and silver from text books and lectures. The practical work in this line consists in treating a given ore by the cyanide, chlorination, hyposulphite or amalgamation process, with or without roasting, and determining the comparative merits of each method upon this given ore, by check assays and analyses. If the ore is of such a nature that it will not admit of all these methods of treatment, two or more ores are used, so as to familiarize the student with each process. After the completion of the theoretical and practical work, a two weeks' excursion is taken to visit the various cyanide and other plants of Deadwood, South Dakota, or other places, where a careful study is made of the process and a detailed typewritten report is made by the class of each plant and process investigated.

The laboratory for this work is equipped with cyanide outfits, a chlorination barrel, an amalgamation plate and a calcining furnace, capable of being used as a reverberatory or muffle roasting furnace.

Junior, second semester, three hours recitations and three hours laboratory work per week.

Metallurgy of Lead.—The subject of the metallurgy of lead is taken up the first semester of the Senior year and completed in about twelve weeks. The subject is presented in the form of lectures and text book work. The theoretical work is followed by metallurgical excursions to the lead smelter at Helena or the lead smelters of Salt Lake City, and notes and reports required of the students covering the examinations made at the works.

After the completion of the subject of metallurgy of lead, the Senior class takes up the subjects of the metallurgy of iron, zinc, aluminum, etc.

The laboratory work of the Senior class consists in metallurgical experimentation, the basis of the work being the

experiments as given in Howe's "Metallurgical Laboratory Notes."

A given ore, from a certain locality and containing paying quantities of any valuable mineral, is also given each member of the class. He analyzes it and determines the composition and mineral values, then by suitable tests determines the best method by which the ore should be treated. He then proceeds to design a plant suitable for the reduction of this ore, calculating the cost per ton of metal to place on the market. He makes a complete report of his experiments and gives the reasons for the deductions he has drawn. All original drawings in connection with this work remain the property of the school, but the student can make and retain any blue-prints that he may desire. Text Books.—Collins' Metallurgy of Lead, Hofman's Metallurgy of Lead, Ingalls' Metallurgy of Zinc, Richard's Metallurgy of Aluminum.

Senior, throughout the year, three hours per week classroom; second semester, three hours per week laboratory.

Electrometallurgy.—The course in electrometallurgy is a lecture and laboratory course dealing with chemical analysis by using the electric current and with the preparation and refinement of metallurgical products.

Senior, second semester, first term, six hours per week.

Gas Analysis.—In this course the student is given practice in taking samples of gas for analysis and in analyzing the more important gases found in mine and smelter work.

Junior, first semester, second term, three hours per week.

MECHANICS

PROFESSOR BOWMAN, PROFESSOR CRAVEN

Physics.—Throughout the course in physics the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown and finally enter the laboratory and make a series of physical measurements. While the general subject of physics is covered, it is the aim to develop most thoroughly such parts as add directly to the working knowledge of the mining engineer.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. Principles and fundamental methods are considered of great importance in this elementary course. Among the topics considered may be mentioned: concurrent and parallel forces; center of gravity; resistance and work; simple machines; gravity and motion; inertia and rotation. A series of about 400 problems is solved during this course. In the mechanics of fluids the fundamental principles are developed through a series of lecture demonstrations. During the latter part

of the semester the subject of heat is introduced; aside from the nature and measurement of heat, its application to the steam engine and to the transmission of energy by means of compressed air is considered. The text books used are: Elements of Mechanics, by Merriman; Elementary Lessons in Heat, by Tillman.

Sophomore, first semester, five hours per week.

Physics.—The second course in physics includes a thorough study of the elements of electricity and magnetism and a brief study of light and sound. The principles and application of electricity to dynamos, motors, the transmission of energy, lighting, etc., are most essential parts of the course. The work in light includes a study of optical instruments and of the phenomena met with in the study of mineralogy and petrography.

During the last term of the semester the class work of the year is supplemented by practice, four hours per week, in the laboratory. Constants in the domain of mechanics and heat are determined, and a familiarity is acquired with simple electrical measurements, the running and behavior of dynamos and motors, etc. Electrical Catechism, by Shepardson, is used as a text book.

Sophomore, second semester, six hours per week.

Applied Mechanics.—This course is a sequence to the analytical mechanics which is made a part of the integral calculus. The laws of elasticity and resistance of materials are studied and applied to the proportioning of pipes; cylinders and riveted joints; the general theory of beams; cantilever beams; and continuous and restrained beams. In this work the graphical solutions are developed as well as the analytical solutions. The application to columns or struts is developed and to shafting for transmitting power. Finally a number of special subjects are taken up which are of interest to the engineer, such as resilience and work, impact and fatigue, true and internal stresses. Throughout the course numerous problems are solved selected from engineering practice and illustrating the theory developed. The course also includes a study of the properties and uses of various building materials, the metals, timber, stone, brick, cement, etc. Merriman's Mechanics of Materials is used as a text book.

Junior, first semester, three hours per week; second semester, two hours per week.

Applied Mechanics.—It is the object of this course to direct the student's attention to the elements of design of mining machinery. It is necessary to devote a considerable portion of the time to the study of simple mechanisms, such as screws, nuts, bolts, keys, pipes and pipe fitting, shafting, couplings, supports for shafts, etc. A study is also made of gearing, outlines of gear teeth, cams, linkwork, belts and rope gearing, etc. The application to mining machinery is found in the catalogues furnished us by manufacturers. Special attention is given to the installation and maintenance

of machinery, and in this connection a great deal of practical information is obtained by frequent visits about the repair shops of the mines of Butte.

Junior, first semester, two hours per week.

Hydraulics.—A knowledge of the subject of hydraulics is of importance to the mining engineer, especially to the engineer whose field of labor is in the west. The course is introduced with a brief review of hydrostatics and theoretical hydraulics. A systematic study is then made of problems involved in the study of the flow of water through orifices, over weirs, through pipes and conduits. Attention is given to the elements of design of dams for water supply and for mining and other purposes. The immense use of water power for mining purposes prompts an investigation of the various turbines and impulse wheels. Merriman's Treatise on Hydraulics is used as the text book.

Junior, second semester, three hours per week.

Mechanical Engineering of Power Plants.—The discussion of the power plant is preceded by a course of lectures and recitations on Thermodynamics. Attention is paid to the definitions and units in the domain of heat, work, and power. The laws of thermodynamics are thoroughly developed and numerous related problems are solved. Following this course a systematic study is made of the mechanism of engines, non-condensing, condensing, simple, and continuous expansion engines, valves, and valve gearing with their various governing attachments, engine foundations, bed-plates, etc. Steam boiler types are studied together with their setting, management, etc. The designing and construction of chimneys and the general plans for power houses are also made a part of this course.

During this course a series of lectures is offered, essentially descriptive of pumps and pump details, special attention being given to the construction and management of mining pumps. The course is based on "Pumping Machinery," by William M. Barr. The text book used is Steam Engines and Boilers, by Kenneally.

Senior, first semester, three hours per week.

Power Transmission.—The extensive use of electric power, together with the abundant water supply for power purposes in the west, have prompted us to give rather extended attention to this branch of engineering. The elementary principles are laid down during the Sophomore year. In the Senior year the student's attention is directed to the general conditions of power transmission, power transmission by continuous current, some properties of alternating circuits, power transmission by alternating currents, synchronous and induction motors, current reorganizers, hydraulic development, the organization of a power station, line construction, centers of distribution, the commercial problems, and measurement of electrical energy. The numerous electrical plants about Butte offer opportunities for observing most excellent

practice in this line of engineering. The text book used is *Power Transmission*, by Bell.

Senior, second semester, three hours per week.

Graphics.—The work in Graphics follows the Junior course in mechanics. The course is intended to familiarize the student with graphical methods of obtaining the stresses in the members of any of the common structures intended to support a load above an opening,—a roof, bridge or truss. A detailed study is made of the proportions of the various standard roof trusses, attention being given to loads due to materials, wind, snow, etc. Analysis is made of single-span trusses of various types with horizontal chords, trusses with inclined chords, and continuous trusses. In these problems concentrated and uniform loads are considered, stresses due to a locomotive, also stresses due to wind, etc. The work is carried out in the drawing room, supplemented by lectures and recitations. Steel Mill Building, by Ketchum, is used as a basis. Twelve practical problems are presented and solved in the drawing room.

Senior, first semester, first term, nine hours per week.

Engineering Construction.—This course consists of lectures and recitations on modern practice in engineering construction. Among the subjects covered may be mentioned: details of mill building, both frame and steel; constructions of retaining walls, foundations, dams, etc., cement, reinforced concrete. The lectures deal with the many practical points in construction and in the handling and care of material. The text book used is Ketchum's Steel Mill Building.

Senior, second semester, two hours per week.

MINING AND MINING ENGINEERING

PROFESSOR SIMONS, MR. COREY

Instruction in the various branches under this department is given by lectures and recitations, by excursions to mines, mills, and smelters within easy reach of the students, by field work in surface and underground surveying, and by practical work in and about mines during the summer vacation.

Surveying.—Lectures and recitation, including description of surveying instruments, their construction, adjustment, use and care. Form of field notes for different methods of surveying, computation of elevations, areas, quantities of material, from data secured in the field. Solution of problems in surveying, requiring a thorough knowledge of algebra, geometry, and trigonometry. Practical use of surveying instruments on the school grounds.

Freshman, second semester, four hours per week.

Surveying.—A course of lectures and recitations on un-

derground surveying and on surface surveys; including location of roads, pipe lines, ditches and flumes for mining purposes; survey for surface and aerial tramways; staking out buildings, structures, tracks, etc., required at a mine. The course in underground surveying also includes the solution of numerous surveying problems, requiring a thorough knowledge of mathematics. Exercises in platting and in preparing cross and longitudinal sections of underground workings; calculating quantities of material removed from the stopes, and of tonnage or blocked out ore bodies.

Sophomore, second semester, two hours per week.

Surveying.—A six weeks' trip in the field by the Freshmen, at the end of the second Freshman semester. During their stay in the field the students are required to execute the following surveys and prepare the necessary field notes, maps, profiles, calculation sheets, etc.: Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain. Determination of true meridian by solar observation and by observation on Polaris. Traverse survey with transit and steel tape, angles by repetition, azimuth and by deflection. Problems in public land surveying in accordance with Manual of Instruction to U. S. Deputy Surveyors. Official survey of mining claims in application for U. S. patent; returns to consist of letter of transmittal, plat, field notes and computations, in form for transmission to U. S. Surveyor General. Topographic survey with transit and steel tape. Stadia and trigonometric survey. Base line and triangulation. Leveling for profile, for contour lines and for establishment of bench marks. Determination of elevations by aneroid barometer. Staking out buildings and excavations for foundation and calculation of quantities to be excavated. Survey of ditch or flume line. Preliminary and location survey of railroad.

Freshman, summer course of six weeks.

Surveying.—A six weeks' trip in the field by the Sophomores at the end of the second Sophomore semester. During their stay in the field the students are required to execute the following surveys and prepare the necessary field notes, maps, profiles, calculation sheets, etc.: Establishment of a base line and determination of its true bearing by solar on Polaris observation. Complete survey of the surface arrangement of a mine, showing all buildings and structures, shaft, adits, etc., with their relative elevations. Complete survey of the underground workings of a mine, including shafts, levels, raises, winzes and stopes. Plumbing a vertical shaft by various methods. Calculating latitudes and departures of underground surveys and preparing a survey record, showing station numbers, horizontal and vertical angles, slope and horizontal distances, true bearing, latitude and departure of all courses; the coordinates for each station N., S., E. and W. of an assumed initial point; also the elevation of each station above an assumed datum, calculated from the vertical angles and slope distances. Checking surveys by

platting and calculation, and adjusting allowable errors by approved methods. Four weeks are spent exclusively in surveying and mapping; the remaining two weeks are devoted to the study of mining operations at the mine.

Sophomore, summer course of six weeks.

Topographical Drawing.—This subject follows the practical field surveying of the Freshman class. The work consists in platting on a convenient scale the surveys executed in the field. During the preparation of the various topographical sheets, the students are instructed in the use of conventional signs for surface representations, including additional conventions required by the mining engineer, such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, mills, etc. The students also receive directions in the construction of contour lines and in laying out railroads and wagon roads, dams, reservoirs, flumes, ditches, etc., on contour maps, and in calculating the quantities of fills and cuts, the capacity of reservoirs, etc., by cross sections made from such contour maps. In this work special attention is given to lettering, titles, borders, and north points, and general neatness in execution.

Sophomore, second semester, six hours per week.

Mine Mapping.—This subject follows the practical field work of the Sophomore class and consists in platting the underground and surface surveys made at the time on a conventional scale; also making cross and longitudinal sections and projections of stopes. The students are instructed in the various methods of platting and the relative merits of each method.

Junior, first semester, second term, three hours per week.

Mining.—An outline of the geographical and geological distribution of the ores of the useful metals. Prospecting, discovery, locating and acquiring title to mining claims. Breaking ground by the various methods of hand work, rotary and percussion drills. Explosives and their use. Supporting excavations by timbering, masonry and metallic supports. The lectures and recitations are illustrated by drawings, prints, models and frequent visits to local mines, where mining operations are observed.

Junior, second semester, three hours per week.

Mining.—Exploitation of the useful metals by open works, hydraulicking, dredging, wells, bore holes and the various methods of underground stoping. Mine haulage, including surface transportation for mining purposes. Hoisting by hand, steam, compressed air and electricity. Ventilation, natural and artificial. Drainage, including the various appliances for pumping. Lighting and sanitary arrangements.

Senior, first semester, second term, two hours per week.

Ore Dressing.—Lectures and recitations on the art of ore dressing. Description of the construction and operation of the principal types of crushers, rolls, stamps, screens,

classifiers, jigs, vanners and concentrating tables. The lectures are amplified by frequent visits to local mills and ore dressing plants, where the students are afforded unequalled opportunities for the study of the details of concentrating and the design of individual plants.

Senior, first semester, second term, five hours per week.

Ore Dressing.—A theoretical and mathematical study of the laws of crushing, the principles of sizing, the laws of jigging, of free and hindered settling. The study of design and methods of ore dressing at various plants described in professional papers. Practical work of ore testing in local concentrating works, the managers of which have offered the use of ore dressing machines to the students of the School of Mines for such purposes.

Senior, second semester, three hours per week.

Mining Engineering.—Lectures and recitations on the duties of a mining engineer. The superintendence and management of a mine. The study of local conditions in relation to economical mining. Water supply for domestic and mining purposes; the installation of complete plants for mining purposes, both on the surface and underground. The computation of power required and the selection of engines, compressors, hoists, etc., from catalogues of manufacturers. Mining economics and mine accounts. Leases, options and royalties. Examination and reporting on mines and mining enterprises.

Senior, second semester, three hours per week.

DRAWING AND DESIGNING

PROFESSOR SIMONS, PROFESSOR CRAVEN, PROFESSOR
SCHIERTZ, PROFESSOR BOWMAN

Mechanical Drawing.—The primary object of instruction in mechanical drawing is to lay the foundation for the skill, neatness, and speed necessary to pursue the subsequent courses. The beginner in this subject should supply himself first with first class instruments; a good set will serve him for years after his course in school is completed, while an inferior set will cause annoyance and loss of time almost from the beginning. The following list is recommended; other minor necessities may be supplied as suggested later by the instructor: One 5½ inch compass, one 3¼ inch bow divider, one 3¼ inch bow pencil, one 3¼ inch bow pen, one 5-inch ruling pen, one 8-inch 30°x60° amber triangle, one 8-inch 45°x45° amber triangle, one 12-inch architect's triangular scale, one T-square—36-inch blade, one drawing board 24x32 inches.

Throughout this course the student applies himself in the drawing room, becoming familiar with the use of drawing instruments and the elements of projections and sections.

He is required to complete a given number of plates drawing the projections, sections, and intersections of simple objects which are merely described to him. While the instructor is always present to assist and see that no time is lost in useless endeavor, it is the aim to guard against the copying of drawings; the student must learn to think and construct for himself. A short time of each period is given to the rapid drawing of problems previously assigned in descriptive geometry. The course also includes practice in free-hand lettering work. Mechanical Drawing, by Faunce, and Descriptive Geometry, by Faunce, are the text books used.

Freshman, first semester, nine hours per week.

Mechanical Drawing.—The second course in mechanical drawing continues the subjects laid down in the first course. The study of descriptive geometry is completed and applied to more difficult problems. During this course the student is taught the use of water colors as applied to engineering drawings, practice is given in coloring maps and shading parts of machine drawings. As far as possible the problems in drawings are taken from those met by the mining engineer in practice; when the student completes his course he is equipped with drawings of the standard timber sets used in mines, with drawings of shaft timbers, with the conventions used in mine and geological maps, and many other useful items used in mining. The text books are the same as used in the first course.

Freshman, second semester, six hours per week.

Machine Design.—This course is an application of the material presented in the second course in applied mechanics. The object is to give instruction in machine drawing so that repair parts for hoists, crushers, rolls, stamps, etc., may be correctly designed and represented. Attention is given to conventions, sections, correct lettering, and dimensioning. The problems are given entirely by dictation. Machine Design, by Low and Bevis, and Kent's Mechanical Engineer's Hand Book are used as reference books. Several copies of these volumes are to be found on the tables of the drawing room.

Junior, first semester, second term, six hours per week.

Mining Engineering Design.—In this work the students are taught to make designs of structures in wood, masonry, and metal, such as are required of the mining engineer. These designs include ore and coal bins, railroad trestles, head frames, and various buildings found at a mine, such as boiler, compressor, and warehouses, hoist house, and general offices. The problems with all conditions and requirements are dictated to the students in the classroom. Numerous blue-prints obtained from actual structures are on file for reference.

Junior, second semester, six hours per week.

Mining Engineering Design.—Leading up from the design

of single structures, this course consists in the design of a complete plant for one or more of the operations of mining and ore dressing. Besides the design and arrangement of a plant for the exploitation of the mine, each student also makes a design of a complete concentrating and stamp mill. It is the aim in this course to develop the originality of the student; although the professor in charge is always present to assist, the student is thrown upon his own resources as far as possible. He is required to make use of catalogues and reference books to obtain the data necessary for the completion of his problem. Attention is given to assembling, bills of materials, and the item of costs. The problems are given to the students and discussed in the classroom.

Senior, first semester, second term, and second semester, six hours per week.

Sketch Club.—The name of "Sketch Club" has been applied to the classes which go on trips during the second semester to visit the mines and smelters of the city. The students are accompanied by at least two professors, who point out items of interest and assist the students in sketching standard engineering devices which may be of use in after practice. The students are taught to observe operations with an engineering interest, which is a most beneficial habit to acquire.

Junior, second semester, three hours per week.

EQUIPMENT.

The equipment of the School of Mines has been secured through appropriations made by the legislature of the state. The total sum invested for this purpose now amounts to nearly \$40,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The descriptions which follow concern the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

DEPARTMENT OF MATHEMATICS.

The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

DEPARTMENT OF CHEMISTRY AND METALLURGY.

In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigating is great, and the successful prosecution

of the purpose for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been devoted to the use of this department, together with a lecture room on the second floor. In this space four laboratories have been fitted up, one for qualitative and quantitative analysis, one for metallurgy and two professors' laboratories. To these have been added a balance room, a store room of laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast, Bunsen burners, a rack for chemical reagents and a cupboard with lock and key so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The laboratories for qualitative and quantitative analysis and for metallurgy are sufficient for the accommodation of 48 students each.

The students' balance room is provided with six analytical balances for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls or floors of the building so that the vibration is reduced to a minimum.

The professors' laboratories and preparation rooms are equipped with modern conveniences for carrying on analytical work. In these rooms all the chemical reagents are prepared for the use of the students in the laboratories and all check analyses on the students'

work are made. Two dark rooms are provided for photographic work, spectrum analysis, making blue prints and lantern slides.

The chemical lecture room, located on the second floor, is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

The assay laboratory is situated on the first or basement floor of the building, and is equipped with six of the latest model coal assay furnaces. There are also two gas assay furnaces, which can be used for special work, and a gas retort and melting furnace for melting bullion, making alloys, retorting amalgam, casting copper and other anodes, etc.

The pulp room adjoins the assay laboratory, where all charges are weighed and fluxed. Convenient cupboards are provided for storing samples. The silver and gold balances are located in the same room as the analytical balances, and are of the latest approved design.

The ore dressing room is provided with a Gates crusher, a Low crusher, an Englebach grinder, capable of grinding pulp to 80 mesh, a buckboard, tables upon which to roll samples, and a series of drawers capable of holding 454 twenty-five pound pulp samples. Our supply of assay samples consists of a large number of copper, lead, gold, and silver ores, together with mattes, both copper and lead, slags, flue-dusts, calcines, concentrates, tailings and all smelter products from the copper and lead smelters and other plants of the state. Each student is required to collect, crush, grind and buck five twenty-

five pound samples in the assay course, and to cut down and assay these samples.

In the assay laboratory are located separate cyanide outfits for testing ore by the cyanide process. There is also located in this laboratory, a calcining furnace capable of being used as a reverberatory or muffle roasting furnace, where large lots can be simply calcined, or a chlorination roast can be made by the hyposulphite treatment. There are arrangements for treating free milling gold ores by the amalgamation process, as well as cyaniding the tailings from this process.

Gas analysis is at present carried on in the chemical lecture room. There is a very complete set of Hempel's gas apparatus, and analyses are made of gases of combustion, reverberatory and blast furnace, illuminating gases, etc.

A dark room for students' use adjoins the balance room, which contains a large Kirchhoff-Bunsen spectroscope and supplementary apparatus for qualitative analytical work in determining the presence of the alkali and alkaline earth metals by their volatilization in the non-luminous flame of the Bunsen burner. The spectroscope is provided with a scale for the determination of the exact location and relative position of the lines of the spectra, or, two spectra may be studied and compared at the same time.

DEPARTMENT OF MINING ENGINEERING.

A room, 24 by 31 feet, is provided on the second floor for lectures in the various branches of mining engineering. The drawing classes occupy one large, well-lighted room, 30 feet by 60 feet, on the third floor, and one room, 30 feet by 30 feet, on the second floor. Ample table room and individual drawer room are provided throughout; cabinets for filing

drawings and drawing boards are also provided. A large collection of drawings furnished by various manufacturing companies of mining machinery is on hand and is used as an aid to the student in developing new work. The collection of parts of machines is gradually increasing. This material is of great assistance to the department in developing the work in machine design.

For the practical work in surveying the following have been provided: Six engineering transits; one from Buff and Buff, one from C. L. Berger & Sons, three from Gurley, and one from Keuffel and Esser. Four levels—one from Buff, one from Gurley, one from Keuffel and Esser and one from Berger. One solar compass and one sextant with artificial horizon, from Gurley; two aneroids by Short and Mason (London), and a collection of minor apparatus, including Brunton compass, clinometers, Locke levels, chains, tapes, plummets, shaft plumbing equipment, rods and flags, necessary in carrying on the work of the department. To this equipment has recently been added by donation a plane table with alidade, a Breithaupt and Sons' level with tripod and a Tacher's calculating instrument.

A mine model has been constructed in the school shops for use in the lecture room, which greatly facilitates the solving of many of the more complicated problems in mine surveying.

The Legislative Assembly of 1907 appropriated the sum of \$45,000 for the construction of a metallurgical laboratory at the Montana School of Mines. Such a laboratory will necessarily include ample provision for ore dressing. Plans for the ore dressing rooms of the new building are in course of preparation. They will contain one or more of each of the approved ore dressing appliances, arranged in such

order as will permit the students to carry out complete tests for the mechanical treatment of various kinds of ore preparatory to the metallurgical treatment. The apparatus contemplated for this plant will include a battery of stamps with amalgamating plates, various types of ore crushers and rolls, elevators, trommels, sizing screens, jigs, Huntington mill, concentrating and slime tables, hydraulic classifiers, a magnetic separator, etc.

The museum of the school contains a very complete collection of the products from the ore dressing plants at the Butte, Anaconda and Great Falls smelters. These samples are extensively used in lectures on ore dressing, as they show in a most eloquent manner the mechanical changes which a particle of ore undergoes during its travel through the various machines, designed to separate the valuable metal from its gangue.

On the tables of the school library may be found all the leading American technical magazines as well as many foreign publications. The library also contains a valuable collection of text books on all the subjects of civil and mining engineering, the use of which is open to all students upon application to the librarian. The office of the Professor of Mining Engineering also contains a large collection of catalogues, blue prints, and bulletins from leading manufacturers of mining, milling, and smelting machinery. The school is indebted to these manufacturers for the supply of such catalogues and for the many extra copies which they have kindly furnished for distribution among the students.

Several mine maps, an ideal section of a Butte copper vein, a very instructive section through part of the Great Falls concentrator, and a great number of appropriate photographs and drawings decorate

the walls of the museum and library; these include views of Montana mining towns, the Washoe smelter at Anaconda, of the Boston & Montana smelter at Great Falls and of various mines and mills about the State. There is a large drawing to illustrate the method of sampling in use at the Taylor & Brunton Sampling Works (now the Washoe Sampling Works) at Butte, and also several drawings of the coal washery of the Cottonwood Coal Company. Finally there are several diagrams, illustrating the relative production of copper, silver and gold in Montana and other states.

The various mine models, donated from time to time by leading mining companies of Butte, are exceedingly useful in demonstrating not only the geological features indicated on such models, but also the various phases and methods of shaft sinking, drifting, cross-cutting and stoping, practiced in the mines represented by said models.

DEPARTMENT OF GEOLOGY AND MINERALOGY.

The Department of Geology and Mineralogy occupies eight rooms; one, on the first floor, is designated the museum; three rooms on the second floor are known as the lecture room, the office, and the mineralogical laboratory; four rooms on the third floor include the dark room, the storage room, the thin section lathe room, and the petrographic laboratory.

The museum is 31 feet square; it is occupied by an extensive collection of concentrator and smelter products, a collection of copper ores with their associated country rocks from the mines of Butte; a collection of minerals of economic or scientific interest, a series of models of mines in Butte, a large geologically colored topographic model of the United States,

certain metallurgical models, and photographs of mines and metallurgical plants.

A very complete set of the products of the metallurgical processes in use at the Boston & Montana smelter at Great Falls is installed in one of the museum cases; this includes an exhibit of electrolytic slime together with ingots showing the exact amount of copper, silver and gold recovered from a definite amount of this slime. There are also several views of the interior of the smelter and adjoining properties, as well as a flow sheet of the concentrator connected with the plant.

The Butte Reduction Works is represented by a large number of its metallurgical products, including concentrates, tailings, mattes, sulphur-coated ore, etc. The products of the Washoe smelter are also present, including samples of the copper cakes and anodes produced at Anaconda.

Copper ores from all the large mines of Butte occupy several of the plate glass cases in the museum; some of these ores are average samples, others are as rich as can be obtained; some samples show mixtures of several ore minerals, and others are massive or crystalline samples of a single mineral. In connection with these ores the country rocks of the Butte district are exhibited, as well as veins in the rock, and samples of crystallized minerals of all the types found in the district. Slickensided samples of ore show that movement has taken place after the deposition of some of the ore.

Other cases in the museum contain samples of minerals from all parts of the world; the samples shown are nearly all crystallized and of especial interest from the economic or scientific point of view. A sample of artificial arsenolite, or commercial arsenic, occupies a place in one case; it is produced by

refining the flue dust at the Washoe smelter by a double sublimation.

A collection of gold crystals belonging to the museum is ordinarily kept in a vault; it consists of about one hundred and fifty samples of crystallized gold collected from about twenty million dollars' worth of placer gold passing through the Helena assay office in former years.

One corner of the museum is occupied by a geological relief map of the United States modeled on a section of a globe sixteen feet in diameter; it shows the topography as well as the geology of the whole country.

The mine models in the museum may be briefly described as follows: The Black Rock-Niagara model was constructed of wood, tape, and colored threads by R. G. Brown for the Niagara Mining Company. The Colusa Parrot and Never Sweat mines are shown by four different models; one shows the geology of the veins on vertical sections on glass, a second shows all the mine workings of both mines on horizontal sections on glass, another shows the surface, the vein structure, and the mine workings by means of a simple wooden block appropriately shaped and colored, and cut in two places to show the conditions in these vertical sections, and the fourth shows all the workings of both mines by means of wooden blocks representing the stopes, raises, winzes, shafts, etc. This model is accompanied by a map of the workings in the district of these mines made for the Colusa Parrot Mining Company. The Pennsylvania and Rarus mines are illustrated by means of a model also built of wood representing the mine workings, and colored to show those stopes that belong to given veins. The Wappelo and Butte & Boston properties are shown by means of

vertical sections on glass connected by appropriately shaped and colored strips and rods of wood and metal representing the mine workings. It was made by C. C. Rueger.

In addition to the mine models there are two metallurgical models in the museum; one is a model of the Holthoff-Wethey calcining furnace, as in use at the Butte Reduction Works, showing the device by means of which the rails and wheels supporting the harrows are kept outside of the furnace proper; the other is a model of the Pratt centrifugal ore sizer for sizing ore before it is run over Wilfley tables.

A large colored diagram shows an "Ideal Section of a Butte Copper Vein;" it was constructed by the Geological Department of the Anaconda Copper Mining Company, and has been reproduced in a leading mining journal, and also in the latest text book on economic geology.

Several appropriate photographs and drawings decorate the walls of the museum and library; these include views of Montana mining towns, of the Washoe smelter at Anaconda, of the Boston & Montana smelter at Great Falls, and of various mines and mills about the State. In addition, there is a large drawing to illustrate the method of sampling in use at the Washoe Sampling Works, and several drawings of the coal washery of the Cottonwood Coal Company.

The material belonging to the museum is so extensive that more than half of it has been crowded out of the museum room into other rooms of the department.

The lecture room, on the second floor, is 24 by 31 feet; it is provided with large blackboards, and diagrams showing the relative production of various

metals in Montana and other states. A map, made at the School of Mines, and hung in this room, shows all the important mineral districts of Montana, including the districts producing precious metals and also those rich in coal. Other maps and photographs are available for use. In this room are two museum cases containing some of the building stones of Montana; crystallized copper ores from Butte showing pseudomorphs by incrustation of chalcopyrite upon enargite, and then chalcocite upon the chalcopyrite; native copper deposited from mine waters in the mine timbers of Butte; samples of cave deposits from the Morrison cave at Limespur, Montana; samples of stibnite and oxidized antimony ore from Garfield County, Utah; samples of hot spring deposits from the only known hot spring deposit of commercial limonite at Anaconda; samples of scheelite, of cerargyrite, of native gold, etc.; and samples of corundum ore and sized corundum from near Bozeman with corundum from the mines of Ontario for comparison.

The office room is 20 by 22 feet; it contains the departmental library of standard works on geology, mineralogy, petrography, and paleontology, the lecture collection of minerals classified according to the chief base present, several collections of ores and minerals of special districts, a collection of rocks and minerals from the Yellowstone Park, three series of crystal models, two being in wood and one in celluloid, several series of petrographic rock types from Montana and other regions, a collection of fossils representing all geological horizons, a collection of minerals for determination in the laboratory by the students, a case of chemical and laboratory apparatus, desks, tables, hood, hydraulic blast, oven with automatic temperature regulator, combustion furnace, etc.

In addition, the apparatus at hand for work in field geology includes Brunton compasses, Attwood clinometer, Abney mine level, aneroid barometers, tapes, geological hammers, note books, topographic maps, kodaks, collecting bags, etc.

The mineralogical laboratory is 31 feet square; it contains six laboratory tables, each 11 feet long by 4 feet wide, provided with water and gas; the table tops are of plate glass with aluminum rims. Each table will accommodate six students at one time; each student is provided with complete apparatus for rapid determination of minerals, and for blowpipe practice. A case in one corner of the mineralogical laboratory contains a series of minerals designed to illustrate all their physical characters, such as hardness, fusibility, structure, luster, color, etc. Another case contains application goniometers, pycnometers, Westphal balance, Plattner scales, burettes, agate mortars, and miscellaneous laboratory supplies. Elsewhere in the room are Jolly balances, an analytical balance, a hood, hot plate, hydraulic blast and suction connections, and footpower blast.

The dark room on the third floor contains apparatus and chemicals for photographic work, and also a camera for taking photographs of objects seen under the microscope. In the same room the reflection goniometer is installed for exact measurements of the angles of crystals.

The storage room contains material collected for study or for the museum, which has not been prepared for use. It also contains records showing the production of precious metals in Montana for several years past. Further, it contains reserve copies of publications issued by officers of the department, as well as various maps, crystal drawings, etc.

The thin section lathe room contains complete

equipment for making thin sections of rocks and minerals. The lathes are two in number; one has two laps for rough and fine grinding of sections, the other has a wire and also a wheel for cutting slices of rocks or minerals; both are driven by an electric motor. Emery, Canada balsam, glass slides, and all other accessories are at hand for use.

The petrographic laboratory is 31 feet square; it contains a series of three hundred and thirty-six thin sections with accompanying hand samples of rocks arranged to illustrate all the petrographic types as described by Rosenbusch, a series of oriented thin sections of important rock-forming minerals, a series of one hundred thin sections with accompanying hand samples of rocks to illustrate rock types as arranged by Ward, and over three hundred additional thin sections of rocks and minerals with their accompanying hand samples. There are also one hundred and twenty-five wooden models to illustrate the crystal forms and twinning laws of the common rock-forming minerals. The colored chart of Michel Levy and Lacroix is used in studying the birefringence of minerals. Microscopes are provided for each student; the latest model French microscopes are used, and all the useful accessories are available, including revolving stage, immersion objectives, Bertrand lenses, Federoff inclining stage, Michel Levy comparator, reflection refractometer, and the Lacroix axial goniometer.

The petrographic laboratory contains also several cases of museum material. Thus, two cases contain samples of coal from all the important coal mining districts in the State, others contain samples of gold, silver, copper, and lead ores from various mining counties in Montana. Besides this, there are samples of graphite, coke, molybdenite, clays, gypsum, onyx,

mineral paints, and oil from various parts of the State. Then there is a collection of one hundred natural crystals arranged to illustrate all the common crystal forms found in nature. Another series is a collection of rock samples arranged to illustrate all kinds of features of physical geology. Another group is a series of mineral samples from Montana and other districts. Still other collections illustrate the geology of particular districts, especially in Montana. Finally, there are collections of fossils from the Tertiary basin of Paris, and from some of the classic districts in the eastern part of the United States.

DEPARTMENT OF MECHANICS.

This department occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons, and is provided with modern lecture room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics, electricity, sound and light. The physical laboratory is equipped with heavy tables and apparatus for the measurement of physical constants. The apparatus consists of the usual assortment required in the measurement of density, elasticity, force of gravity, the latent heats of fusion and evaporation, the mechanical equivalent of heat, etc. There is also a good photometer, together with the necessary accessories. For the measurements in electricity, there are provided ammeters, voltmeters, resistance boxes, Wheatstone bridges, galvanometers, batteries, keys, etc.

The engine and dynamo room is located in the basement of the building; there is installed here a gas engine of fifteen horsepower, from which is belted a line shaft driving direct and alternating cur-

rent dynamos. A switchboard connects these machines with lines running to various parts of the building, also to motors and a rotary converter and to a bank of transformers. It is possible to illustrate most of the connections in power transmission systems with the apparatus at hand as well as to perform many interesting tests. A storage battery of ten cells is also connected to the switchboard so that any number of them may be connected to any of the circuits for lecture or experimental purposes. The requisite voltmeters and ammeters for both alternating and direct current, rheostats, etc., are provided. The laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements.

In connection with this laboratory there is a small shop equipped with the following metal working machines; one thirteen-inch screw cutting lathe; one sixteen-inch shaper; one twenty-two inch drill. The tool cabinets are provided with a good equipment of bench tools for both metal and wood work. There is also a small blacksmith shop used for making and repairing tools and for giving such students as may desire it, practice in forge work in iron and steel.

In addition to the material mentioned above the testing laboratory has at its disposal a 100,000-pound Olson machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Olson compression micrometer especially designed for measuring the compression of stone cubes and other building material; one Olson improved deflection instrument for measuring the deflection of beams subjected to load; one Henning's improved micrometer instrument for measuring the compression or elongation of long specimens. The

laboratory is also equipped with a cement testing outfit from Fairbanks, Morse & Co. All accessories, such as molds, sieves, etc., are at hand for making a thorough study of this important subject. The apparatus for making a complete indicator and brake test of an engine are provided, also the apparatus for making a study of the heating power of coals.

THE LIBRARY.

The number of publications in the library, departmental and others, is nearly 4,000. As a United States Depository for Public Documents, the shelves contain the issues of the United States Geological, and Coast and Geodetic Surveys; Reports on Forestry, Forest Reserves and Irrigation; and of the Naval Observatories and Engineering Corps. Besides these the library receives the official scientific reports of various state surveys, and of Mexico, Canada, Great Britain, France, Norway, Cape of Good Hope, New Zealand, and the states of Australia. In addition to this abundance of technical and scientific literature all the more important standard reference works are procured as they are published.

The leading scientific, mining engineering and geological magazines are to be found on the library tables, and as fast as the several volumes of these are completed they are bound and thus furnish in permanent form more or less complete discussions of the latest and most important advances that have been made in their several departments. To these are added the bound volumes of the proceedings of the great scientific societies, such as the Geological Society of America, the American Chemical Society, and the American Institute of Mining Engineers, etc.

A valuable collection of the standard works and

treatises on the various branches of science taught in technical schools has been secured by donation.

THE MARCUS DALY COLLECTION.

This collection of technical scientific books was purchased from a fund of \$300, donated by Mrs. James W. Gerard, of New York City, and is named in honor of her father, the late Marcus Daly. To this have been added other technical works purchased from the surplus of the registration fees of the School of Mines.

MAGAZINES.

The following technical and general magazines and periodicals will be found in the library and in the rooms of the members of the faculty, where they may be freely consulted by the students:

American Journal of Science.
American Review of Reviews.
Annales de Chimie et de Physique.
Annals of Mathematics.
Berichte d. d. Chemischen Gesellschaft.
Bulletin de la Societe Geologique de France.
Bulletin of the Geological Society of America.
Cassier's Magazine.
Centralblatt fur Mineralogie, Geologie, und Paleontologie.
Chemical Abstracts.
Chemical News.
Comptes Rendus.
Economic Geology.
Electrical World.
Electrical Age.
Electrochemical and Metallurgical Industry.
Engineering.
Engineering and Mining Journal.
Engineering News.
Geologisches Centrallblatt.
Indian Engineering.
Iron Age.
Iron and Steel Magazine.
Iron Trade Review.
Journal of the American Chemical Society.
Journal of the Association of Engineering Societies.

Journal of the Chemical Society of London.
Journal of Geography.
Journal of Geology.
Journal of the Geological Society of Tokio.
Literary Digest.
Machinery (Engineering Edition).
Mineral Industry.
Mineralogical Magazine.
Mines and Minerals.
Mining and Scientific Press.
Mining Reporter.
Mining World.
National Geographical Magazine.
Nature.
Neues Jahrbuch fur Geologie, Mineralogie, etc.
Outlook.
Popular Science Monthly.
Quarterly Journal of the Geological Society of London.
Salt Lake Mining Review.
School of Mines Quarterly.
Science.
Transactions of the American Institute of Mining Engineers.
Tschermak's Mineralogische und Petrographische Mittheilungen.
Zeitschrift fur Kristallographie.
Zeitschrift fur Praktische Geologie.

The following newspapers are kindly furnished by their publishers free of charge:

The Ravalli Democrat (weekly), Hamilton.
Great Falls Leader (daily), Great Falls.
The Missoulian (daily), Missoula.
Blue Mountain American (weekly), Baker City, Oregon.
The Tribune-Review (weekly), Butte.
The Evening News (Daily), Butte.
The Basin Progress (weekly), Basin.

GENERAL INFORMATION.

BUTTE.

It is no longer necessary to call attention to the fact that Butte is one of the greatest mining centers of the world. The discoveries and developments of the past year, and the enormous investment of capital in the mines of this city by the leading financiers and mining men of this country and Europe have given to this locality such publicity that no one now needs to be told of its leading position in the mining world.

Following a long period in which its mineral product, though larger than that of any other field, was kept far below its capacity by reason of conflict of title to mining ground, a settlement has been effected which will permanently remove all such restriction in its output. New life has been infused, new mines located, and such aggregations of capital have been enlisted, as promise a vast increase in its production for a generation to come. With this increase in production, there has come a largely increased demand for copper, and a consequent advance in prices, that must for some years to come make the mining of the red metal in Butte one of the most profitable industries of the world.

The great reduction plants that have heretofore handled the ore that comes from the mines of this city must be enlarged to treat the enlarged product. The modern devices for reducing the expense of treatment will be developed on a larger scale, and all of this increase in every department of the mining

industry goes to render this place the more desirable as a location for a mining school.

In a very important sense all these mining plants of every description are a part of the substantial equipment of the school, because its pupils are brought into daily contact with the men who are personally engaged in the various departments of this industry and are thoroughly conversant with all the details of the work.

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions are made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expenses to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter; the opportunity is here presented for daily observation of works whose development and whose product have given to Butte the reputation of being the greatest mining center in the world.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them; but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place, permission is given to the mining classes to witness the same, under the guidance of their instructors.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

In addition to these comparatively short excursions, the freshmen spend six weeks of their summer vacation time in camp, where they are given fifty hours per week in learning the use of instruments, and in such exercises as are detailed on page 30. The juniors, in like manner, spend six weeks of their summer vacation in underground surveys, in the mines, under the direction of the professor in charge of mining engineering, and in map drawing to show underground workings. In like manner the junior class spends six weeks making geological surveys in some one of the interesting geological fields of this and adjoining states.

Through the courtesy of the great mining companies, as well as the smaller operators, and individual miners, the students of the School of Mines have every proper opportunity of visiting these mining plants and observing the operations therein conducted. The great practical advantage that thus accrues to the mining student cannot be overestimated.

EXPENSES

Fees.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deduction will be made to those who attend for only part of the semester.

DEPOSITS

To secure the State against loss for apparatus that may be broken or damaged by the student, a deposit is required at the beginning of the year from each one engaged in laboratory work.

This deposit is placed in the hands of the Treasurer of the Board of Trustees. Each student is charged with the apparatus issued to him. At the close of the year he is credited with such articles as he returns in good order. The balance of this account is then returned to him.

The following is the list of deposits that are required:

FRESHMAN YEAR

General Chemistry and Qualitative Analysis....	\$15.00
Surveying.	10.00

SOPHOMORE YEAR

Quantitative Analysis.....	\$15.00
Mineralogy.	10.00

JUNIOR YEAR

Metallurgy and Assaying.....	\$10.00
Mine Surveying	10.00

SENIOR YEAR

Petrography.	\$10.00
Metallurgy.	10.00

When the breakage exceeds the deposit the student will be required to make good the full amount of the damage done.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishing. For those who find it necessary to economize, there are few cities that afford as favorable opportunities for self-help as are found here.

DONATIONS

DONATIONS TO THE LIBRARY

Valuable gifts of books, reports, and pamphlets have been received during the year beginning May 1, 1906, and ending March 31, 1907, from:

Andrews, E. C., Geologist, Sydney, New South Wales, Australia.

Bell, Robert, Director Geological Survey, Ottawa, Canada.

Brown, H. Y. L., Government Geologist, Adelaide, South Australia.

Clark, William B., State Geologist, Baltimore, Maryland.

Denny, G. A., Consulting Mining Engineer and Metallurgist, London, England.

Dewey, Melville, State Librarian, Albany, New York.

Gregory, J. W., Director Geological Survey, Melbourne, Victoria, Australia.

Haanel, Eugene, Provisional Superintendent of Mines, Ottawa, Ontario, Canada.

Henriksen, G., Government Inspector of Mines, Christiania, Norway.

Lane, Alfred C., State Geologist, Lansing, Michigan.

Liversidge, A., Prof., Sydney, South Australia.

Maitland, A. Gibb, Government Geologist, Perth, West Australia.

McBride, Richard, Minister for Mines, Victoria, British Columbia.

McGowan, James, Minister for Mines, Wellington, New Zealand.

Michel, Levy A., Director Geological Survey, Paris, France.

Norwood, C. J., State Geologist, Lexington, Kentucky.

Orton, Edward, Jr., State Geologist, Columbus, Ohio.

Rogers, A. W., Director Geological Survey, Cape Town, South Africa.

Rueger, C. C., Superintendent Lexington Mine, Butte, Montana.

Teall, J. J. H., Director Geological Survey, London, England.

Watson, Thomas L., State Geologist, Blacksburg, Virginia.

DONATIONS TO THE MUSEUM AND EQUIPMENT

Cobban, R. M., Butte, Montana—Epidote from near Butte.
Irelan, A. L., Helena, Montana—Gold ore from Ruby Gulch, Montana.

Morrison, D. A., Limespur, Montana—Cave specimens from Morrison Cave, near Limespur.

Rueger, C. C., Butte, Montana—Mine model, Lexington mine; plane table and alidade; surveyor's level; mineral collection.

Utah Antimony Company, Butte, Montana—Large specimen of stibnite with cervantite, from near Coyote, Utah.

LIST OF STUDENTS

SENIOR CLASS

Adami, Arthur E.....	Helena, Montana
Bovett, Clifford A.....	Seattle, Washington
McCracken, Ralston H.....	Butte, Montana
Reardon, Daniel J.....	Butte, Montana
Schafer, William A.....	Waco, Texas

JUNIOR CLASS

Bowden, Malcolm.....	Helena, Montana
Ellis, Willis H.....	Butte, Montana
Foote, Frank A.....	Butte, Montana
Ketcham, Samuel H.....	Clinton, Montana
Lomas, Percy.....	Butte, Montana
Lowry, Thomas M.....	Butte, Montana
McLaughlin, William D.....	Butte, Montana
Meiklejohn, Archie B.....	Butte, Montana
O'Brien, Albert.....	Goldfield, Nevada
Patten, Earle.....	Phillipsburg, Montana
Proctor, Israel O.....	Great Falls, Montana
Proctor, Merton D.....	Great Falls, Montana
Schiffner, Otto E.....	Minneapolis, Minnesota
Villars, Jesse R.....	Arkansas City, Kansas
Walton, Lee M.....	Dillon, Montana
Wren, Andrew A.....	Los Angeles, California

SOPHOMORE CLASS

Baker, Jacob H.....	Butte, Montana
Corr, Frank R.....	Butte, Montana
*Dubie, Edward D.....	Butte, Montana
Evans, James.....	Butte, Montana
Haines, Peter.....	Westresand, Lofoten, Norway
Harlan, Clyde C.....	Kansas City, Missouri
Harris, Frank.....	Butte, Montana
Hoffman, David A.....	Great Falls, Montana
Johnstone, J. Clark.....	Butte, Montana
Kane, Edward E.....	Butte, Montana
Kirby, Kenneth P.....	Butte, Montana
Loughran, Michael.....	Butte, Montana
Malloy, Edward E.....	Butte, Montana
Morton, C. H.....	Toledo, Iowa
Peters, Ira B.....	Butte, Montana
Stockett, Norman A.....	Bankhead, Alberta, Canada
Weigenstein, Henry J.....	Butte, Montana
Williams, Daniel J.....	Spokane, Washington
Young, William A.....	Giltedge, Montana

*Deceased.

FRESHMAN CLASS

Condon, George.....	Anaconda, Montana
Cotter, W. T.....	Canton, Montana
Dyer, Burt W.....	Livingston, Montana
Furlong, Leslie P.....	Rockford, Illinois
Grunert, August.....	Butte, Montana
Heimerdinger, Vern.....	Butte, Montana
Hinkle, Fred R.....	Butte, Montana
Howell, Henry.....	Butte, Montana
Jensen, W. H.....	Great Falls, Montana
LaMotte, Ross G.....	Great Falls, Montana
Messer, Julius.....	Lambrecht, Bavaria, Germany
Moore, Fred N.....	Butte, Montana
Ostrander, H. S.....	Butte, Montana
Peterson, Evert.....	Terraville, S. Dakota
Ralston, Edward L.....	Dewey, Montana
Sherman, H. C.....	Helena, Montana
Stuewe, William.....	Helena, Montana
Sullivan, George.....	Butte, Montana
Tobin, Maurice.....	Butte, Montana

SPECIAL STUDENTS

Alamos, Gmo A.....	Santiago, Chili
<i>Metallurgy.</i>	
Fenlon, W. J.....	Chicago, Illinois
<i>Mechanics.</i>	
Fogarty, Edmond A.....	Sandeliffs, Montana
<i>Mineralogy and Mathematics.</i>	
Kyle, Robert G.....	Butte, Montana
<i>Mineralogy and Geology.</i>	
McIntyre, Alex. J.....	Butte, Montana
<i>Mineralogy and Geology.</i>	
Ossa, Ignatius Diaz.....	Santiago, Chili
<i>Metallurgy.</i>	
Stubbs, D. E.....	Anaconda, Montana
<i>Mineralogy and Geology.</i>	
Williams, Mattie.....	Butte, Montana
<i>Mechanical Drawing.</i>	

REGISTER OF ALUMNI.

Class 1903

Bender, Louis V.....Anaconda, Montana
Chemist, Anaconda Copper Mining Co.

Class 1904

Balmforth, Alfred J.....Tombstone, Arizona
Mining Engineer, Old Glory Mining Co.
 Clark, Clara.....Butte, Montana
 Duling, Fred J.....Tonopah, Nevada
Mining Engineer, MacDonald & Moran Co.
 Irelan, Arthur J.....Helena, Montana
Mining Engineer, County Surveyor.
 Kuphal, Henry E.....Missoula, Montana
Mining Engineer.
 Stevenson, Isabel Little.....Sumpter, Oregon
 MacRae, Lachlan D.....Butte, Montana
Mining Engineer, Boston & Montana Mining Co.
 McGee, John.....Kendall, Montana
Superintendent Barnes-King Mining Co.
 Pauly, P. L.....Kendall, Montana
Foreman, Barnes-King Mining Co.
 Tallant, H. S.....Butte, Montana
Sampler and Timekeeper, East Colusa Mine.

Class 1905

Archibald, George.....Butte, Montana
Surveyor, Butte & Bacorn Mining Co.
 Brinton, O. F.....Butte, Montana
Surveyor, LaFrance Copper Co.
 Corey, Clarence R.....Butte, Montana
Instructor, Montana School of Mines.
 Duthie, John M.....Butte, Montana
Assistant City Engineer.
 Elford, Basil.....Tonopah, Nevada
Mining Engineer.
 Mackel, Louis C.....Sumpter, Oregon
Mining Engineer, Eastern Oregon Mining Co.
 Pratt, Paul D.....Libby, Montana
Mining Engineer.
 Stevenson, Leon C.....Sumpter, Oregon
Manager, Orleans Gold Mining Co.
 Van Gundy, Jay.....The Dalles, Oregon
Surveyor, O. R. & N. Railroad Co.

Class 1906

Dugan, John F.....	Butte, Montana
<i>Surveyor, Anaconda Copper Mining Co.</i>	
Feeney, Charles W.....	Butte, Montana
<i>Surveyor, Anaconda Copper Mining Co.</i>	
Geiser, Herbert S.....	Butte, Montana
<i>Surveyor, Butte & Boston Mining Co.</i>	
Johns, John W.....	Butte, Montana
<i>Surveyor, Barker & Wilson.</i>	
Kane, Louis M.....	Butte, Montana
<i>Mining Engineer, Boston & Montana Mining Co.</i>	
Warfield, Herschel J.....	Butte, Montana
<i>With Boston & Montana Mining Co.</i>	
Wilson, T. Bert.....	Ely, Nevada
<i>Mining Engineer, Butte & Ely Co.</i>	
Young, Siegfried A.....	Hereford, Arizona
<i>Mining Engineer, Butte & Arizona Co.</i>	
Young, Arthur B.....	Libby, Montana
<i>Mining Engineer.</i>	

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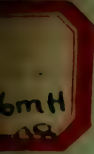
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THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

CATALOGUE
OF THE
MONTANA STATE
SCHOOL OF MINES

BUTTE, MONTANA
1907-1908

MONTANA STATE
SCHOOL OF MINES
BUTTE, MONTANA

EIGHTH ANNUAL CATALOGUE
OF OFFICERS AND STUDENTS
FOR THE YEAR
1907-1908

WITH ANNOUNCEMENTS FOR THE YEAR
1908-1909

C
M. 76mH
1101-08

CALENDAR FOR 1908-1909

1908

August 28 and 29, Entrance and Special Examinations.
September 1, First Semester begins.
October 30, Close of First Term, First Semester.
November 2, Second Term, First Semester begins.
November 26, Thanksgiving Day.
December 23, End of First Semester.

1909

January 4, Second Semester begins.
February 22, Washington's Birthday.
March 12, close of First Term, Second Semester.
March 15, Second Term, Second Semester begins.
May 28, Commencement Day.
May 31 to July 9, Mine Surveying, Sophomores.
July 12 to August 21, Field Work in Geology, Juniors.
July 12 to August 21, Field Work in Surveying, Freshmen.
August 30, First Semester begins.

CALENDAR

1908							1909							1910						
JULY							JANUARY							JULY						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
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19	20	21	22	23	24	25	17	18	19	20	21	22	23	18	19	20	21	22	23	24
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AUGUST							FEBRUARY							AUGUST						
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30	31																			
SEPTEMBER							MARCH							SEPTEMBER						
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NOVEMBER							MAY							NOVEMBER						
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27	28	29	30	31			27	28	29	30				26	27	28	29	30		

BOARDS OF CONTROL

STATE BOARD OF EDUCATION.

Members Ex-Officio.

EDWIN NORRIS, Governor of the State,
President of the Board.

W. E. HARMON, Superintendent of Public Instruction,
Secretary of the Board.

ALBERT J. GALEN, Attorney General.

Term Expires 1911

E. O. BUSENBURG,	Lewistown
N. W. McCONNELL,	Helena

Term Expires 1910

JOHN M. EVANS,	Missoula
C. R. LEONARD,	Butte

Term Expires 1909

G. T. PAUL,	Dillon
C. N. KESSLER,	Helena

Term Expires 1908

O. P. CHISHOLM,	Bozeman
S. D. LARGENT,	Great Falls

COMMITTEE ON SCHOOL OF MINES

E. O. BUSENBURG,
G. T. PAUL,
C. R. LEONARD.

BOARD OF TRUSTEES.

Term Expires 1908

H. L. FRANK, <i>President of the Board.</i>	Butte
N. R. LEONARD, <i>Treasurer of the Board.</i>	Butte
CHARLES MATTISON.	Butte

Term Expires 1909

JAMES D. SLEMONS,	Butte
C. W. GOODALE,	Butte

H. C. HOPKINS,
Secretary of the Board.

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CHARLES H. BOWMAN, M. S.,
President and Professor of Mechanics.

GEORGE W. CRAVEN, B. S.,
Professor of Mathematics and Drawing.

THEODORE SIMONS, E. M., C. E.,
Professor of Mining and Ore Dressing.

FRANCIS CHURCH LINCOLN, S. B., E. M., A. M.,
Professor of Geology and Mineralogy.

FREDERICK LAIST, B. S.,
Professor of Metallurgy and Chemistry.

LESTER J. HARTZELL, E. M.,
Assistant Professor of Chemistry.

JOHN B. CLAYBERG, L. L. B.,
Lecturer on Mining Law.

CHARLES T. KIRK, A. M.,
Instructor in Geology and Mineralogy.

RALPH E. DAVIS, B. S.,
Instructor in Surveying.

ARTHUR E. ADAMI, E. M.,
Instructor in Metallurgy.

MONTANA STATE SCHOOL OF MINES.

HISTORICAL SKETCH.

The "Enabling Act," which paved the way for the admission of Montana into the Union as a State, contained a provision for a donation of public land for the establishment and maintenance of a state school of mines. The grant provided one hundred thousand acres to be sold at not less than ten dollars per acre, thus insuring ultimately a fund of one million dollars. The date of this act was February 22, 1889. It was a significant date, and it marks the first national provision for education in the interest of the mining industry. This legislation was the natural sequel to the Morrill Act of 1862, which provided for the establishment and maintenance of state colleges for education in agriculture and the mechanic arts. Mining and agriculture stand pre-eminent as factors in the development of the resources of the country and the growth of the nation in wealth and power. It was an enlightened statesmanship that dictated these two systems of education as the best means to secure the best interests of the entire people.

The first Legislative Assembly of the State appointed commissioners to select these lands. They are located mainly in the northwest quarter of the State, and for this reason are not yet salable at the minimum price fixed by Congress, but the prospective increase of immigration following the development of the extensive system of irrigation planned for our State will soon place some of these lands above the minimum value.

ORGANIZATION.

By legislative enactment the Montana School of Mines was located at Butte, the great mining center of the State. Certain public spirited citizens of the city donated a plat of ground 376 feet by 500 feet as a building site for the School. This plat is on the southern bench of "Big Butte," the extinct volcano from which the city takes its name. It is within the limits of the city, and only a few blocks from one of the street car lines. It commands a fine view of the city, the mines, and the smelters, as well as of the great continental divide which bounds the horizon on the east and south.

In 1895 a Building Commission was appointed, and authorized by the legislature to issue bonds, the proceeds of which were to be used for the erection of a suitable building for the School. The building was erected during the years 1896 and 1897 through the use of funds advanced by citizens of Butte, who were repaid in full when the bonds were finally issued in 1900. The bonds issued amount to \$120,000, bearing five per cent interest, and maturing in thirty years, but payable at the option of the State in fifteen years.

The School of Mines building is of brick with stone foundations and trimmings. It has three stories above the basement, including the top floor, which is furnished with skylights as well as windows for illumination. It faces toward the city, that is, toward the east. The length along the front is 118 feet, and the depth is 94 feet. It contains 37,000 square feet of available floor space and in construction fireproof material was used to a large extent.

In the basement the flooring of the halls and of some of the rooms is of cement; elsewhere on this

floor pine floors are used. The largest room in the basement is the chemical laboratory which is 32 by 47 feet; there are four rooms each 23 by 31 feet—they are the furnace room, the engine room, the office of the professor of chemistry, and the assay laboratory. The pulp room, containing gas assay furnaces, is 12 by 24 feet. The metallurgical laboratory is 31 feet square. The office of the assistant professor of chemistry is 9 by 19 feet. The balance room is 18 by 31 feet, while the chemical supply room is 19 by 21 feet, and the rock crushing room 19 by 27 feet.

On the first floor there are two rooms each 31 feet square, viz., the museum and the chemical lecture room; two rooms, each 24 by 31 feet, viz., the mathematics lecture room and the mechanics lecture room; and two rooms, each 14 by 19 feet, viz., the faculty room and the President's office. The physical laboratory is 23 feet square, while the office of the professor is 8 by 23 feet. The library is 23 by 31 feet. The main halls, which are floored with tiling, are 8 feet wide and 114 feet long on each story. The main stairway occupies 20 by 24 feet.

On the second floor there are two rooms, each 31 feet square, viz., the sophomore drawing room and the mineralogical laboratory; two rooms, each 24 by 31 feet, viz., the mining lecture room and the geology lecture room. The office of the professor of mining is 23 by 31 feet; that of the professor of geology is 23 feet square. The front room on this floor is 14 by 50 feet.

On the third floor the petrographic laboratory is 31 feet square; it has been especially arranged to secure abundant light from the north. The mineral storage room is 19 by 24 feet, the dark room is 9

by 14 feet, and the petrographic lathe room is 20 by 24 feet. The freshman drawing room on this floor is 31 by 65 feet; the general storage room is 25 by 115 feet.

The building is heated by steam, and lighted by gas and electricity. It is finished inside in oak and polished in the natural colors; the furnishings are largely finished in golden oak.

The Legislative Assembly of 1907 appropriated \$14,000 for a new boiler and power plant at the School of Mines, and a further sum of \$45,000 for a metallurgical laboratory building and equipment.

The heating plant has been completed and the metallurgical laboratory is now ready to receive the equipment. The laboratory consists of a large mill room measuring 70 by 80 feet, the available height of the room is 34 feet, there is also an engine, dynamo, and compressor room measuring 32 by 32 feet, and a laboratory room, 32 by 32 feet. The equipment of the large room are dressing machinery and appliances, a blast furnace, reverbatory furnace, and a roasting furnace all arranged to treat ore in from one to ten ton lots, using any combination of the equipment desired. It is the expectation to have the plant in operation by the fall of 1908.

The maintenance of the School is provided by the State through biennial appropriations made by the Legislative Assembly. The sum provided by the Assembly of 1907 was \$30,480 per year for the biennium ending February 28, 1909.

The control of the entire system of public education in the State is vested by the Constitution of Montana in the State Board of Education. This Board consists of the Governor of the State, the Attorney General, and the State Superintendent of

Public Instruction, together with eight other members who are appointed by the Governor and confirmed by the Senate. The appointive members hold office for four years.

The legislative act establishing the Montana School of Mines provided for a Board of Trustees to be chosen by the State Board of Education. To the Board of Trustees is committed the immediate supervision of the School, the adoption of a course of study, and the election of the officers and members of the faculty; but all the acts of this body are subject to the approval of the Board of Education. The Trustees hold office for a term of four years.

The aim of the Montana State School of Mines is to furnish the best possible education to those whose life work will be devoted to mining in any of its branches. The School is, therefore, wholly a technical one, not providing an education for the business man, the farmer, or the literary man, but confining its energies entirely to the proper mental equipment of mining men. The course of study, which is fully described in the following pages, has been elaborated with this purpose constantly in mind. Those who complete this course will receive the degree of Engineer of Mines.

REQUIREMENTS FOR ADMISSION.

The Montana State School of Mines is open to residents of Montana and to residents of other states and countries regardless of sex or race, on terms prescribed by the Board of Trustees, provided they are qualified to pursue the studies enumerated on the following pages.

Fifteen units are required for admission to the freshman class. One unit represents nine months'

work with not less than five forty-five minute periods per week; two laboratory, shop, or drawing periods are considered equal to one recitation.

Of the fifteen units required, three are required in mathematics, distributed between algebra and plane and solid geometry; three are required in English composition and literature; and one is required in physics. The remaining eight credits are to be selected from history, modern languages, Latin, elementary science, and manual training.

Candidates for admission who are graduates from an accredited high school will have complied with the above requirements and may be admitted upon presentation of the proper certificate of graduation.

Candidates who have prepared at other institutions of learning are required to bring all grade cards, certificates or diplomas they may possess to be submitted to the Faculty for approval. The right is reserved to examine such candidates in any or all subjects submitted for credit.

Applicants for admission to any of the advanced classes must pass a satisfactory examination in all studies required in the classes preceding the one they desire to enter. Credit will be given for work done in other institutions of recognized rank, provided the candidate can furnish satisfactory proof of having received a passing mark in the work pursued in such institution before leaving. In all cases such students are required to furnish a certificate of honorable dismissal from the institution from which he comes.

Persons of mature years who have had experience in some of the branches of mining and metallurgy and who are not candidates for a degree may be admitted without examination or certificate to any of

the classes they may select on giving satisfactory evidence of their preparation to pursue their studies with profit to themselves and without embarrassment to the classes.

LIST OF ACCREDITED HIGH SCHOOLS IN THE STATE OF
MONTANA.

City High Schools.

Anaconda	Fort Benton
Billings	Great Falls
Butte	Hamilton
Columbus	Helena
Forsyth	Virginia City

County High Schools.

Beaverhead, Dillon	Gallatin, Bozeman
Broadwater, Townsend	Granite, Phillipsburg
Carbon, Red Lodge	Jefferson, Boulder
Custer, Miles City	Missoula, Missoula
Dawson, Glendive	Park, Livingston
Fergus, Lewistown	Powell, Deer Lodge
Flathead, Kalispell	Sweet Grass, Big Timber
Teton, Chouteau	

COURSE OF STUDY

FRESHMAN YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Higher Algebra.....	4.....	4
Trigonometry	5.....	5
Chemistry, Lectures.....	3.....	3
Chemistry, Laboratory.....	6.....	6
English	3.....	3
Mechanical Drawing.....	9.....	9

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Analytical Geometry.....	3.....	3
Descriptive Geometry.....	2.....	2
Chemistry, Lectures.....	3.....	3
Chemistry, Laboratory.....	9.....	9
English	3.....	3
Surveying	4.....	4
Mechanical Drawing.....	6.....	6

Surveying, summer course of six weeks.

SOPHOMORE YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Calculus	5	5
Physics	5	5
Chemistry, Lectures.....	1	1
Chemistry, Laboratory	12	12
Crystallography	7	0
Blowpipe Analysis.....	0	7

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Calculus	5	3
Physics	4	6
Chemistry, Laboratory.....	6	6
Chemistry, Lectures.....	1	1
Descriptive Mineralogy.....	2	2
Determinative Mineralogy.....	4	4
Mine Surveying.....	2	2
Topographical Drawing.....	6	6

Mine Surveying, summer course of six weeks.

JUNIOR YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mechanics	5.....	5
Machine Design	2.....	2
Dynamical Geology.....	5.....	0
Structural and Physiographical Geology	0.....	8
Metallurgy, Assaying.....	12.....	0
Metallurgy, Introduction.....	3.....	3
Gas Analysis	0.....	3
Testing Laboratory.....	3.....	0
Drawing, Mapping.....	0.....	3
Drawing, Designing	0.....	6
Metallurgical excursion to copper smelter, one week.		

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Historical Geology.....	3.....	3
Economic Geology	5.....	3
Mechanics of Materials.....	3.....	3
Hydraulics	2.....	2
Mining	2.....	2
Metallurgy, Copper.....	3.....	3
Metallurgy, Laboratory.....	3.....	3
Geological Excursion	3.....	3
Drawing, Designing	6.....	6
Mining and metallurgical excursion, 2 weeks.		
Field Geology, summer course of six weeks.		

SENIOR YEAR

FIRST SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mechanical Engineering of		
Power Plants.....	3.....	3
Graphical Statics.....	9.....	0
Mining	2.....	2
Ore Dressing, Lectures.....	0.....	5
Metallurgy, Gold and Silver.....	3.....	3
Metallurgy, Laboratory.....	3.....	3
Engineering Design.....	0.....	6
Petrography	2.....	2
Petrography, Laboratory.....	6.....	6
Metallurgical excursion to lead smelter, 1 week.		

SECOND SEMESTER.

	First term Hours per week.	Second term Hours per week.
Mining Engineering	3.....	3
Ore Dressing.....	3.....	3
Metallurgy, Lead and Zinc.....	3.....	3
Metallurgy, Laboratory.....	6.....	6
Mechanical Engineering of		
Power Plants.....	3.....	3
Engineering Design.....	6.....	6
Engineering Construction.....	2.....	2

ENGLISH

MR. KIRK.

English Composition.—This is a course in the principles and practice of English composition. Lectures are given on the whole composition, paragraph and sentence; weekly themes and daily paragraphs are required; notes are taken on assigned readings. The work is intended to supplement the usual high school courses in literature. Instead of dealing with figures of speech and other rhetorical devices, however, it has to do more with the outline, unity, coherence, and emphasis, as applied to exposition and argumentation.

Freshman, first semester, three hours per week.

English—Technical Prose.—This is a continuation of the first course. Studies are made in the structure of modern prose; critiques and model paragraphs are written; lectures are given on words. Training in business correspondence is also given, and special studies made in technical vocabulary.

Freshman, second semester, three hours per week.

MATHEMATICS

PROFESSOR CRAVEN, PROFESSOR BOWMAN.

Algebra.—A short preliminary course is first given, designed to drill the student in the fundamental operations and in the statement and solution of problems. The following topics constitute the chief items for the term's work: Indeterminate coefficients; theory and use of logarithms; limits; introduction to derivatives; binomial and logarithmic series; tests of convergency of series; general theory of equations; solution of numerical equations. The text book used is Wentworth's Higher Algebra.

Freshman, first semester, four hours per week.

Trigonometry.—In plane trigonometry the subjects of primary importance are: Goniometry; solutions of right and oblique triangles; practical problems. The solution of the right and oblique angled spherical triangles is developed and practical application is made to surveying and mensuration. The text book used is Wentworth's Plane and Spherical Trigonometry.

Freshman, first semester, five hours per week.

Analytical Geometry.—In this course a systematic study is made of the following: The point and straight line in a plane; different systems of coordinates; conic sections; discussion of the general equation of the second degree with two variables; higher plane curves; the point and straight line in space; curved surfaces and surfaces of revolution. The text used is Wentworth's Analytic Geometry.

Freshman, second semester, five hours per week.

Calculus.—Among the topics studied in this course may be mentioned: Differentiations, Taylor's theorem; indeter-

minate forms; maximum and minimum; tangents, normals, and asymptotes; curvature and radius of curvature; integration; rectification of curves; areas; volumes; center of mass; moment of inertia. Application is made to numerous problems in mechanics during the latter part of the lectures. The text being presented in the form of lectures. The text book used is Differential and Integral Calculus, by Taylor.

Sophomore, throughout the year, five hours per week.

GEOLOGY AND MINERALOGY.

PROFESSOR LINCOLN AND MR. KIRK.

Crystallography.—The course in Crystallography consists of a short series of lectures supplemented by laboratory and drafting practice. Three hours a week during the term are devoted to crystal drawing and two to the examination of natural crystals and models. The aim is to familiarize the student with the principles of the subject and to enable him to identify crystallographic forms and their combinations. Moses and Parsons' "Elements of Mineralogy, Crystallography and Blowpipe Analysis" is used as a text-book both in this and in the succeeding courses in Mineralogy.

Sophomore, first semester, first term, seven hours per week.

Blowpipe Analysis.—The time given to blowpipe analysis is devoted mainly to laboratory work. Informal lectures and recitations are held from time to time as deemed desirable. The object of the course is to teach the student to use the blowpipe and to make other chemical tests of importance in mineralogy. This course is introductory to that in determinative mineralogy.

Sophomore, first semester, second term, seven hours per week.

Descriptive Mineralogy.—The course consists almost entirely of lectures and is a companion course to that in determinative mineralogy. Crystallography is a prerequisite. The introductory lectures take up the characters of minerals and the occurrence and origin of minerals, then follow the regular lectures describing all the more important mineral species. Special stress is laid on sight determination by assigning one hour each week during the latter part of the course to the examination of the exhibition specimens in the mineralogical museum. By this means the student learns to identify typical specimens by their external appearance alone. The object of the course as a whole is to make the student thoroughly familiar with the appearances, properties, associations, and uses of the economically important minerals and to give him some insight into the practical and scientific problems connected with mineralogy.

Sophomore, second semester, two hours per week.

Determinative Mineralogy.—This course consists entirely of laboratory work and thus supplements the contemporary course in descriptive mineralogy. Blowpipe analysis is a

prerequisite. The operations and principles learned in the earlier course are in this course practically applied to the determination of mineral species. The aim of the exercises is to train the student to determine minerals with accuracy and rapidity by means of physical and chemical tests.

Sophomore, second semester, four hours per week.

Dynamical Geology.—Dynamical geology is presented in a series of lectures which discuss the greater geologic processes:—eruption, deformation, erosion and sedimentation. Scott's "An Introduction to Geology" is used as a text-book.

Junior, first semester, first term, five hours per week.

Structural Geology.—This course occupies the first half of the second term in the Junior year. Descriptive mineralogy is a prerequisite. The course consists of both lectures and laboratory exercises. Scott is used as a text, supplemented by Kemp's "Handbook of Rocks." There are sixteen lectures on the principles of structural geology and sixteen laboratory periods given over to the study of the more common types of igneous, sedimentary and metamorphic rocks. Through this laboratory work, the student becomes familiar with the common rocks and learns to identify them in so far as this can be done without the aid of the petrographical microscope.

Junior, first semester, first half of second term, eight hours per week.

Physiographical Geology.—The second half of the second term in the Junior year is taken up with physiographical geology. Both dynamical and structural geology are prerequisites. There are sixteen lectures on the relation of geologic processes to topography, and sixteen laboratory exercises in interpreting topographic maps and in drawing assigned topographic forms. Scott is supplemented by topographic and geologic maps published by the United States Geological Survey. The course is designed to render the student familiar with the topographical features of the earth and the modes in which they were produced.

Junior, first semester, second half of second term, eight hours per week.

Historical Geology.—This course consists of one lecture and two laboratory hours weekly. The course in Physiographical Geology is a prerequisite. The lectures take up the history of the earth, discussing changes of level between land and sea, of topography, of climate, and of the successive groups of animals and plants which have lived upon the globe. The laboratory work includes a study of those fossils which are the most abundant and the most characteristic indices of the ages of different strata, the identification of unknown material and the working out of practical problems through the aid of fossils.

Junior, second semester, three hours per week.

Economic Geology.—The course in Economic Geology consists of lectures, excursions and drafting exercises. Structural geology is a prerequisite. The lectures treat of the methods of occurrence, geological relations, origin and com-

mercial value of the more important economic deposits in this country. Five lectures weekly for one term are devoted to the subject of ore deposits and three lectures weekly during the second term to that of other mineral deposits of economic value. Ries' "Economic Geology of the United States" is used as a text-book, supplemented by lecture notes. The excursions occupy one afternoon each week for one term and geological mine mapping occupies the same time for a second term.

Junior year, second semester, first term, eight hours per week; second term, six hours per week.

Field Geology.—The course in Field Geology consists in the detailed study of a selected area in the vicinity of Butte. Historical geology is a prerequisite. Instruction is given in observing, recording and interpreting geological phenomena, and in the preparation of geologic maps and sections. Upon completion of the field work, each student is required to submit promptly an accurate and detailed geological report on the area investigated.

Junior, summer course of six weeks.

Petrography.—This course consists of two lectures and two afternoons in the laboratory weekly for one term with laboratory alone for the second term. Structural geology is a prerequisite. The course is introduced by a review of the principals of Optics, after which Optical Mineralogy is studied for the remainder of the term. Luquer's "Minerals in Rock-Sections" is used as a text. The student becomes familiar with the use of the petrographical microscope and is taught to distinguish the commoner rock-forming minerals by microscopic methods. Practice is also given in the preparation of petrographic slides. The second term is devoted to the study of rocks and ore-bearing formations. Har-ker's "Petrology for Students" is used as a text-book. In addition to the thin sections, megascopic specimens of the various rocks are at hand in convenient drawers, and the student is taught to examine these hand specimens at the same time with the slides. This course affords the student an opportunity to become thoroughly familiar with the macroscopic and microscopic characters of the principal rock types and enables him to become acquainted with petrographical theory and its relation to certain problems in Mining Geology.

Senior, first semester, first term, eight hours per week; second term six hours per week.

CHEMISTRY.

PROFESSOR LAIST, ASSISTANT PROFESSOR HARTZELL.

General Chemistry.—The subject of general chemistry is presented through lectures and text books. The object of the course is to develop the underlying principles of chemistry as a basis for all subsequent work in the department. The student is made familiar with the principal characteristics and

relations of the elements, the work is also copiously illustrated with experiments conducted by the instructor. It is necessary that the student should take full notes on the lectures, which are designed to aid and direct the laboratory work of the same semester. Text book Remsen's College Chemistry.

Freshman, first semester, three hours per week.

General Chemistry, Laboratory.—The laboratory course in general chemistry consists in performing a large number of experiments by the students at individual desks. Aside from becoming proficient in the use of apparatus, the student becomes familiar with the different acids, bases and salts, their reactions and relations with each other. It is a part of the work to keep a neat notebook in which are recorded the reactions and statements of the principles involved in each experiment.

Freshman, first semester, six hours per week.

Qualitative Analysis.—The course in qualitative analysis is designed to instruct the students in the general schemes of analysis by which the different metals are detected and separated from each other. The problem of isolating and identifying the acid radicals is also a part of the course. The accompanying lectures give a general outline of the schemes of separation and deal with the merits and difficulties of each, finally pointing out the best method to be used by the mining engineer. The essential element of writing and balancing chemical equations is made a part of the drill work of the class. During the last part of the course the class is introduced to the subject of stoichiometry. The text book used is Prescott and Johnston's "Qualitative Analysis."

Freshman, second semester, three classroom hours and nine laboratory hours per week.

Quantitative Analysis.—The course in quantitative analysis embraces a study of such analyses as the mining engineer meets in practicing his profession in the laboratories of smelters and mine plants. The main object in view is to develop the ability in the student to do this work with the accuracy and the rapidity required in practice, so that the student who completes the course need have no hesitancy to accept a position of this character.

Among the analyses performed may be mentioned the analysis of limestone, dolomites, feldspars, ores of iron, manganese, lead, zinc, arsenic, copper, etc. Analyses are made of mattes, flue dust, concentrates, calcines, and pig-iron. During the course some time is spent on acidimetry and alkalimetry. The laboratory work is performed by the students at individual desks where the best appliances and modern conveniences are at hand. The classroom work consists of discussions and quizzes on the theory of the laboratory work.

Sophomore, first semester, one hour classroom and twelve hours laboratory work per week; second semester, six hours per week.

METALLURGY.

PROFESSOR LAIST, ASSISTANT PROFESSOR HARTZELL, MR. ADAMI.

Introduction to Metallurgy.—The study of metallurgy begins with lectures and recitations on the fundamental principles of the art. The student is familiarized with the names and properties of the commoner metallurgical products. The principles of ore treatment by mechanical and smelting methods are discussed in a general way leaving the more detailed study of the various processes till later in the course. The principles of combustion, amount of air required, heat carried away by gases, product of combustion, etc., are studied. The various fuel, solid, liquid, and gaseous, natural and prepared, and the best way of applying them to attain the desired temperatures are considered. Following this, gas producers and various types of furnaces, i. e., blast, reverberatory, muffle, and electric used in metallurgical operations are studied. In connection with this the methods for utilizing waste heat are discussed. The efficiency of the various types of furnaces are calculated. The source and properties of the various refractory materials and their manufacture into bricks and crucibles and methods of testing are investigated. A few weeks are devoted at the end of the semester to the metallurgy of iron, Text book, Robert-Austin "Introduction of Metallurgy;" L. S. Austin's "Metallurgy of the Common Methods."

Junior, first semester, three hours per week.

Metallurgy of Copper.—The study of the metallurgy of copper is conducted by lectures and recitations covering the subject fully. The electrolytic refining of copper bullion is studied as a part of this course. Immediately after the subject is treated in the lecture and recitation room, one week is devoted to a practical study of the smelter and electrolytic refinery at Anaconda or at Great Falls. Each operation in the treatment of copper ores is studied in detail, among them may be mentioned the processes of concentration, the production of matte by both reverberatory and blast furnaces; the blowing of matte to metallic copper in the converter, and the process of refining matte in the reverberatory refining furnace. Most of the standard methods of concentration, roasting and reduction of copper ores are studied during these visits. A typewritten report of the operations studied is required of each student.

Junior, second semester, three hours per week.

Metallurgy of Gold and Silver.—The first semester of the senior year is devoted to the metallurgy of gold and silver from lectures and text books. The methods of obtaining gold by dredging and sluicing are treated briefly. The larger portion of the time is taken up with a rather detailed study of the cyanide process from both a chemical and economic standpoint. The various methods of crushing, classifying and treatment of sands and slime are treated quite fully. The modern devices for handling the sands and filtering the slimes are studied. The older metallurgical processes for silver, such

as the Washoe process and the hyposulphite lixiviation process are discussed briefly. The course is completed by a two weeks' excursion to visit the various cyanide and other plants of Deadwood, South Dakota, or other places, where a careful study is made of the process and a detailed typewritten report is made by each student of the plant visited.

Senior, first semester, three hours per week.

Metallurgy of Lead and Zinc.—The subject of the metallurgy of lead is taken up the second semester of the senior year. The subject is presented in the form of lecture and text book work. The processes of roasting, pot-roasting and smelting of lead ores are discussed as well as the refining of lead bullion by the Parkes and Pattison processes and by the Betts electrolytic process.

The metallurgy of zinc is treated more briefly and is followed by a short discussion of the methods of reducing aluminum, nickel, etc.

The lecture room work on lead and zinc is followed by metallurgical excursions to the lead smelter at Helena or the lead smelters at Salt Lake City and notes and reports required of the students covering the examinations made at these works.

Senior, second semester, three hours per week.

Assaying.—The subject is presented in the form of lectures with references to text books. The practical work consists of the fire assaying of gold, silver and lead in all varieties of crude ores and smelter products, such as copper and lead slags, copper and lead matte, copper and lead bullion, lead dross and speiss, calcines, flue dust, tailings, etc.

The laboratory is fitted with the most modern appliances and it is a part of the aim of the course to give the student a thorough drill in accuracy and rapidity.

Junior, first semester, first term, twelve hours per week.

Gas and Fuel Analysis.—The student is taught to use the standard types of gas analysis apparatus and determine the commoner and more important constituents of furnace and smelter flue gases. The latter part of the course is taken up with the proximate analysis of coals and cokes and the determination of their heating power by means of the calorimeter.

Junior, first semester, second term, three hours per week.

Metallurgical Laboratory.—The work consists of a series of experiments illustrating various metallurgical processes. The changes which an ore undergoes when subjected to oxidizing or chloridizing roasting are investigated as well as sulphatizing reactions. Some time is devoted to the measurement of high temperatures and a study of the melting points of silicates and slags. The electrolytic refining of copper is studied.

Junior, second semester, three hours per week.

Metallurgical Laboratory.—The laboratory work of the junior year is continued with practice in the methods of ore

testing in the laboratory. Concentration, cyanide and chlorination tests are made with small quantities of ores, the tests being so made that reliable conclusions can be drawn as to what will take place on a large scale. Determinations are made of the proportions of sand and slime produced in crushing ores, the most economical size to crush to, most economical strength of solution to use, cyanide consumption, etc.

Senior, first semester, three hours per week.

Ore Testing Laboratory.—The laboratory work of the second semester of the senior year consists of tests on ton lots of ore in the testing plant. This building is equipped with various styles of crushing and concentrating machinery and with a cyanide and chlorinating plant in which lots of several tons of ore at a time can be treated. There is also a roasting furnace, a reverberatory and a small blast furnace. The work at the concentrating plant and at the furnaces is checked by taking numerous samples and assaying them.

Senior, second semester, six hours per week.

MECHANICS

PROFESSOR BOWMAN, PROFESSOR CRAVEN.

Physics.—Throughout the course in physics the student's attention is directed to a systematic development of the principles of the science. These he must study and in connection solve numerous problems. He must also attend lectures and demonstrations in which the phenomena are shown and finally enter the laboratory and make a series of physical measurements. While the general subject of physics is covered, it is the aim to develop most thoroughly such parts as add directly to the working knowledge of the mining engineer.

During the first semester the student acquires an analytical knowledge of the mechanics of solids and fluids. Principles and fundamental methods are considered of great importance in this elementary course. Among the topics considered may be mentioned: concurrent and parallel forces; center of gravity; resistance and work; simple machines; gravity and motion, inertia and rotation. A series of about 400 problems is solved during this course. In the mechanics of fluids the fundamental principles are developed through a series of lecture demonstrations. During the latter part of the semester the subject of heat is introduced; aside from the nature and measurement of heat, its application to the steam engine and to the transmission of energy by means of compressed airs is considered. The text books used are: *Elements of Mechanics*, by Merriman; *Elementary Lessons in Heat*, by Tillman.

Sophomore, first semester, five hours per week.

Physics.—The second course in physics includes a thorough study of the elements of electricity and magnetism and a brief study of light and sound. The principles and appli-

cation of electricity to dynamos, motors, the transmission of energy, lighting, etc., are most essential parts of the course. The work in light includes a study of optical instruments and of the phenomena met with in the study of mineralogy and petrography.

During the last term of the semester the class work of the year is supplemented by practice, four hours per week, in the laboratory. Constants in the domain of mechanics and heat are determined, and a familiarity is acquired with simple electrical measurements, the running and behavior of dynamos and motors, etc. Electrical Catechism, by Shepardson, is used as a text book.

Sophomore, second semester, six hours per week.

Applied Mechanics.—This course is a sequence to the analytical mechanics which is made a part of the integral calculus. The laws of elasticity and resistance of materials are studied and applied to the proportioning of pipes; cylinders and riveted joints; the general theory of beams; cantilever beams; and continuous and restrained beams. In this work the graphical solutions are developed as well as the analytical solutions. The application to columns or struts is developed and to shafting for transmitting power. Finally a number of special subjects are taken up which are of interest to the engineer, such as resilience and work, impact and fatigue, true and internal stresses. Throughout the course numerous problems are solved selected from engineering practice and illustrating the theory developed. The course also includes a study of the properties and uses of various building materials, the metals, timber, stone, brick, cement, etc. Merriman's Mechanics of Materials is used as a text book.

Junior, first semester, three hours per week; second semester, two hours per week.

Applied Mechanics.—It is the object of this course to direct the student's attention to the elements of design of mining machinery. It is necessary to devote a considerable portion of the time to the study of simple mechanisms, such as screws, nuts, bolts, keys, pipes and pipe fitting, shafting, couplings, supports for shafts, etc. A study is also made of gearing, outlines of gear teeth, cams, linkwork, belts and rope gearing, etc. The application to mining machinery is found in the catalogues furnished us by manufacturers. Special attention is given to the installation and maintenance of machinery, and in this connection a great deal of practical information is obtained by frequent visits about the repair shops of the mines of Butte.

Junior, first semester, two hours per week.

Hydraulics.—A knowledge of the subject of hydraulics is of importance to the mining engineer, especially to the engineer whose field of labor is in the west. The course is introduced with a brief review of hydrostatics and theoretical hydraulics. A systematic study is then made of problems

involved in the study of the flow of water through orifices, over weirs, through pipes and conduits. Attention is given to the elements of design of dams for water supply and for mining and other purposes. The immense use of water power for mining purposes prompts an investigation of the various turbines and impulse wheels. Merriman's Treatise on Hydraulics is used as the text book.

Junior, second semester, three hours per week.

Mechanical Engineering of Power Plants.—The discussion of the power plant is preceded by a course of lectures and recitations on Thermodynamics. Attention is paid to the definitions and units in the domain of heat, work, and power. The laws of thermodynamics are thoroughly developed and numerous related problems are solved. Following this course a systematic study is made of the mechanism of engines, non-condensing, condensing, simple, and continuous expansion engines, valves, and valve gearing with their various governing attachments, engine foundations, bed-plates, etc. Steam boiler types are studied together with their setting, management, etc. The designing and construction of chimneys and the general plans for power houses are also made a part of this course.

During this course a series of lectures is offered, essentially descriptive of pumps and pump details, special attention being given to the construction and management of mining pumps. The course is based on "Pumping Machinery," by William M. Barr. The text book used is Steam Engines and Boilers, by Kenneally.

Senior, second semester, three hours per week.

Power Transmission.—The extensive use of electrical power, together with the abundant water supply for power purposes in the west, have prompted us to give rather extended attention to this branch of engineering. The elementary principles are laid down during the Sophomore year. In the Senior year the student's attention is directed to the general conditions of power transmission, power transmission by continuous current, some properties of alternating circuits, power transmission by alternating currents, synchronous and induction motors, current reorganizers, hydraulic development, the organization of a power station, line construction, centers of distribution, the commercial problems, and measurement of electrical energy. The numerous electrical plants about Butte offer opportunities for observing most excellent practice in this line of engineering. The text book used is Power Transmission, by Bell.

Senior, second semester, three hours per week.

Graphics.—The work in Graphics follows the Junior course in mechanics. The course is intended to familiarize the student with graphical methods of obtaining the stresses in the members of any of the common structures intended to support a load above an opening,—a roof, bridge, or truss. A detailed study is made of the proportions of the various

standard roof trusses, attention being given to loads due to materials, wind, snow, etc. Analysis is made of single-span trusses of various types with horizontal chords, trusses with inclined chords, and continuous trusses. In these problems concentrated and uniform loads are considered, stresses due to a locomotive, also stresses due to wind, etc. The work is carried out in the drawing room, supplemented by lectures and recitations. Steel Mill Buildings, by Ketchum, is used as a basis. Twelve practical problems are presented and solved in the drawing room.

Senior, first semester, first term, nine hours per week.

Engineering Construction.—This course consists of lectures and recitations on modern practice in engineering construction. Among the subjects covered may be mentioned: details of mill building, both frame and steel; constructions of retaining walls, foundations, dams, etc., cement, reinforced concrete. The lectures deal with the many practical points in construction and in the handling and care of material. The text book used is Ketchum's Steel Mill Buildings.

Senior, second semester, two hours per week.

MINING AND MINING ENGINEERING

PROFESSOR SIMONS, MR. DAVIS.

Instruction in the various branches under this department is given by lectures and recitations, by excursions to mines, mills, and smelters within easy reach of the students, by field work in surface and underground surveying, and by practical work in and about mines during the summer vacation.

Surveying.—Lectures and recitations, including description of surveying instruments, their construction, adjustment, use and care. Form of field notes for different methods of surveying, computation of elevations, areas, quantities of material, from data secured in the field. Solution of problems in surveying, requiring a thorough knowledge of algebra, geometry, and trigonometry. Practical use of surveying instruments on the school grounds.

Freshman, second semester, four hours per week.

Surveying.—A course of lectures and recitations on underground surveying and on surface surveys; including location of roads, pipe lines, ditches and flumes for mining purposes; survey for surface and aerial tramways; staking out buildings, structures, tracks, etc., required at a mine. The course in underground surveying also includes the solution of numerous surveying problems, requiring a thorough knowledge of mathematics. Exercises in platting and in preparing cross and longitudinal sections of underground workings; calculating quantities of material removed from the stopes, and of tonnage or blocked out ore bodies.

Sophomore, second semester, two hours per week.

Surveying.—A six weeks' trip in the field by the Freshmen, at the end of the second Freshman semester. During their stay in the field the students are required to execute the following surveys and prepare the necessary field notes, maps, profiles, calculation sheets, etc.: Exercises in pacing, ranging and chaining and solution of geometrical problems with the chain. Determination of true meridian by solar observation and by observation on Polaris. Traverse survey with transit and steel tape, angles by repetition, azimuth, and deflection. Problems in public land surveying in accordance with Manual of Instruction to U. S. Deputy Surveyors. Official survey of mining claims in application for U. S. patent; returns to consist of letter of transmittal, plat, field notes and computations, in form for transmission to U. S. Surveyor General. Topographic survey with transit and steel tape. Stadia and trigonometric survey. Base line and triangulation. Leveling for profile, for contour lines and for establishment of bench marks. Determination of elevations by aneroid barometer. Staking out buildings and excavations for foundation and calculation of quantities to be excavated. Survey of ditch or flume line. Preliminary and location survey of railroad.

Freshman, summer course of six weeks.

Surveying.—A six weeks' trip in the field by the Sophomores at the end of the second Sophomore semester. During their stay in the field the students are required to execute the following surveys and prepare the necessary field notes, maps, profiles, calculation sheets, etc.: Establishment of a base line and determination of its true bearing by solar and Polaris observation. Complete survey of the surface arrangement of a mine, showing all buildings and structures, shafts, adits, etc., with their relative elevations. Complete survey of the underground workings of a mine, including shafts, levels, raises, winzes and stopes. Plumbing a vertical shaft by various methods. Calculating latitudes and departures of underground surveys and preparing a survey record, showing station numbers, horizontal and vertical angles, slope and horizontal distances, true bearing, latitude and departure of all courses; the coordinates for each station N., S., E. and W. of an assumed initial point; also the elevation of each station above an assumed datum, calculated from the vertical angles and slope distances. Checking surveys by platting and calculation, and adjusting allowable errors by approved methods. Four weeks are spent exclusively in surveying and mapping; the remaining two weeks are devoted to the study of mining operations at the mine.

Sophomore, summer course of six weeks.

Topographical Drawing.—This subject follows the practical field surveying of the Freshman class. The work consists in platting on a convenient scale the surveys executed in the field. During the preparation of the various topographical sheets, the students are instructed in the use of

conventional signs for surface representations, including additional conventions required by the mining engineer, such as those for geological outcrops, stratification, mineral veins, shafts, tunnels, mine dumps, mills, etc. The students also receive directions in the construction of contour lines and in laying out railroads and wagon roads, dams, reservoirs, flumes, ditches, etc., on contour maps, and in calculating the quantities of cut and fill, the capacity of reservoirs, etc., by cross sections made from such contour maps. In this work special attention is given to lettering, titles, borders, and north points, and general neatness in execution.

Sophomore, second semester, six hours per week.

Mine Mapping.—This subject follows the practical field work of the Sophomore class and consists in platting the underground and surface surveys; also making cross and longitudinal sections and projections of stopes. The students are instructed in the various methods of platting and the relative merits of each method.

Junior, first semester, second term, three hours per week.

Mining.—An outline of the geographical and geological distribution of the ores of the useful metals. Prospecting, discovery, locating and acquiring title to mining claims. Breaking ground by the various methods of hand work, rotary and percussion drills. Explosives and their uses. Supporting excavations by timbering, masonry and metallic supports. The lectures and recitations are illustrated by drawings, prints, models and frequent visits to the local mines, where mining operations are observed.

Junior, second semester, three hours per week.

Mining.—Exploitation of the useful metals by open works, hydraulicking, dredging, wells, bore holes and the various methods of underground stoping. Mine haulage, including surface transportation for mining purposes. Hoisting by hand, steam, compressed air and electricity. Ventilation, natural and artificial. Drainage, including the various appliances for pumping. Lighting and sanitary arrangements.

Senior, first semester, second term, two hours per week.

Ore Dressing.—Lectures and recitations on the art of ore dressing. Description of the construction and operation of the principal types of crushers, rolls, stamps, screens, classifiers, jigs, vanners and concentrating tables. The lectures are amplified by frequent visits to local mills and ore dressing plants, where the students are afforded unequalled opportunities for the study of the details of concentrating and the design of individual plants.

Senior, first semester, second term, five hours per week.

Ore Dressing.—A theoretical and mathematical study of the laws of crushing, the principles of sizing, the laws of jigging, of free and hindered setting. The study of design and methods of ore dressing at various plants described in

professional papers. Practical work of ore testing in local concentrating works, and in the metallurgical laboratory recently added to the school.

Senior, second semester, three hours per week.

Mining Engineering.—Lectures and recitations on the duties of a mining engineer. The superintendence and management of a mine. The study of local conditions in relation to economical mining. Water supply for domestic and mining purposes; the installation of complete plants for mining purposes, both on the surface and underground. The computation of power required and the selection of engines, compressors, hoists, etc., from catalogues of manufacturers. Mining economics and mine accounts. Leases, options and royalties. Examination and reporting on mines and mining enterprises.

Senior, second semester, three hours per week.

DRAWING AND DESIGNING

PROFESSOR SIMONS, PROFESSOR CRAVEN, PROFESSOR
BOWMAN.

Mechanical Drawing.—The primary object of instruction in mechanical drawing is to lay the foundation for the skill, neatness, and speed necessary to pursue the subsequent courses. The beginner in this subject should supply himself with first class instruments; a good set will serve him for years after his course in school is completed, while an inferior set will cause annoyance and loss of time almost from the beginning. The following list is recommended; other minor necessities may be suggested later by the instructor: One $5\frac{1}{2}$ inch compass, one $3\frac{1}{4}$ inch bow divider, one $3\frac{1}{4}$ inch bow pencil, one $3\frac{1}{4}$ inch bow pen, one 5-inch ruling pen, one 8-inch $30^{\circ}\times 60^{\circ}$ amber triangle, one 8-inch $45^{\circ}\times 45^{\circ}$ amber triangle, one 12-inch architect's triangular scale, one T-square—36-inch blade, one drawing board 24×32 inches.

Throughout this course the student applies himself in the drawing room, becoming familiar with the use of drawing instruments and the elements of projections and sections. He is required to complete a given number of plates drawing the projections, sections, and intersections of simple objects which are merely described to him. While the instructor is always present to assist and see that no time is lost in useless endeavor, it is the aim to guard against the copying of drawings; the student must learn to think and construct for himself. A short time of each period is given to the rapid drawing of problems previously assigned in descriptive geometry. The course also includes practice in free-hand lettering. Mechanical Drawing, by Faunce, and Descriptive Geometry, by Faunce, are the text books used.

Freshman, first semester, nine hours per week.

Mechanical Drawing.—The second course in mechanical drawing continues the subjects laid down in the first course. The study of descriptive geometry is completed and applied to more difficult problems. During this course the student is taught the use of water colors as applied to engineering drawings, practice is given in coloring maps and shading parts of machine drawings. As far as possible the problems in drawings are taken from those met by the mining engineer in practice; when the student completes his course he is equipped with drawings of the standard timber sets used in mines, with drawing of shaft timbers, with the conventions used in mine and geological maps, and many other useful items used in mining. The text books are the same as used in the first course.

Freshman, second semester, six hours per week.

Machine Design.—This course is an application of the material presented in the second course in applied mechanics. The object is to give instruction in machine drawing so that repair parts for hoists, crushers, rolls, stamps, etc., may be correctly designed and represented. Attention is given to conventions, sections, correct lettering, and dimensioning. The problems are given entirely by dictation. Machine Design, by Low and Bevis, and Kent's Mechanical Engineer's Hand Book are used as reference books. Several copies of these volumes are to be found on the tables of the drawing room.

Junior, first semester, second term, six hours per week.

Mining Engineering Design.—In this work the students are taught to make designs of structures in wood, masonry, and metal, such as are required of the mining engineer. These designs include ore and coal bins, railroad trestles, head frames, and various buildings found at a mine, such as boiler, compressor, and warehouses, hoist house, and general offices. The problems with all conditions and requirements are dictated to the students in the classroom. Numerous blue-prints obtained from actual structures are on file for reference.

Junior, second semester, six hours per week.

Mining Engineering Design.—Leading up from the design of single structures, this course consists in the design of a complete plant for one or more of the operations of mining and ore dressing. Besides the design and arrangement of a plant for the exploitation of the mine, each student also makes a design of a complete concentrating and stamp mill. It is the aim in this course to develop the originality of the student; although the professor in charge is always present to assist, the student is thrown upon his own resources as far as possible. He is required to make use of catalogues and reference books to obtain the data necessary for the completion of his problem. Attention is given to assembling, bills of materials, and the item of costs. The problems are given to the students and discussed in the classroom.

Senior, first semester, second term, and second semester, six hours per week.

Sketch Club.—The name of "Sketch Club" has been applied to the classes which go on trips during the second semester to visit the mines and smelters of the city. The students are accompanied by at least two professors, who point out items of interest and assist the students in sketching standard engineering devices which may be of use in after practice. The students are taught to observe operations with an engineering interest, which is a most beneficial habit to acquire.

Junior, second semester, three hours per week.

EQUIPMENT.

The equipment of the School of Mines has been secured through appropriations made by the legislature of the state. The total sum invested for this purpose now amounts to nearly \$40,000, and represents a careful selection of the latest and best apparatus for the different departments of the school. The descriptions which follow concern the more important articles that have been procured to illustrate or to facilitate the work in the several departments.

DEPARTMENT OF MATHEMATICS.

The work in this department is to lay a solid foundation for a large part of the scientific discussions which are necessarily connected with all branches of the study of engineering. Fortunately it does not demand an extensive equipment. At the School of Mines it is furnished merely with a large recitation and lecture room on the second floor, abundantly supplied with blackboard space, and with slate, terrestrial and celestial globes, some simple models and a blackboard ruled in squares for tracing the graphs of equations and of natural phenomena.

DEPARTMENT OF CHEMISTRY AND METALLURGY.

In this, as in all other departments where laboratory work is required, the demand for a large and varied equipment of apparatus and facilities for investigation is great, and the successful prosecution of the purpose for which the technical school is maintained is directly related to the perfection of this equipment. Nearly three-fourths of the entire first floor or basement of the School of Mines has been

devoted to the use of this department, together with a lecture room on the second floor. In this space four laboratories have been fitted up, one for qualitative and quantitative analysis, one for metallurgy, and two professors' laboratories. To these have been added a balance room, a store room for laboratory supplies and a dispensary where the prepared tests for the students in the laboratories are kept.

The laboratories are furnished with working desks of the most approved pattern—each student having his own particular stand—where he is supplied with gas, water, blast, Bunsen burners, a rack for chemical reagents and a cupboard with lock and key so that he can keep securely the apparatus and material assigned for his use. The laboratories are also supplied with hoods in which are to be found hot plates, air baths, steam evaporating pans, hydrogen-sulphide apparatus and a flue with a strong draft to draw off the noxious vapors. The laboratories for qualitative and quantitative analysis and for metallurgy are sufficient for the accomodation of 48 students each.

The students' balance room is provided with six analytical balances for the use of students in the laboratories. These balances are placed on stands which rest on piers disconnected from the walls and floors of the building so that the vibration is reduced to a minimum.

The professors' laboratories and preparation rooms are equipped with modern conveniences for carrying on analytical work. In these rooms all the chemical reagents are prepared for the use of the students in the laboratories and all check analyses on the students' work are made. Two dark rooms are provided for photographic work, spectrum analysis, making blue prints and lantern slides.

The chemical lecture room, located on the second

floor, is provided with a demonstrating table, furnished with pneumatic trough, gas, water, hydrogen and oxygen blast and a direct and alternating current of electricity up to 750 volts and 45 amperes. The demonstrating table is backed with a hood furnished with the same appurtenances as are provided for the hoods in the laboratories.

The assay laboratory is situated on the first or basement floor of the building, and is equipped with six of the latest model coal assay furnaces. There are also two gas assay furnaces, which can be used for special work, and a gas retort and melting furnace for melting bullion, making alloys, retorting amalgam, casting copper and other anodes, etc.

The pulp room adjoins the assay laboratory, where all charges are weighed and fluxed. Convenient cupboards are provided for storing samples. The silver and gold balances are located in the same room as the analytical balances, and are of the latest approved design.

The ore dressing room is provided with a Gates crusher, a Low crusher, an Englebach grinder, capable of grinding pulp to 80 mesh, a buckboard, tables upon which to roll samples, and a series of drawers capable of holding 454 twenty-five pound pulp samples. Our supply of assay samples consists of a large number of copper, lead, gold, and silver ores, together with mattes, both copper and lead, slag, flue-dusts, calcines, concentrates, tailings, and all smelter products from the copper and lead smelters and other plants of the state. Each student is required to collect, crush, grind and buck five twenty-five pound samples in the assay course, and to cut down and assay these samples.

In the assay laboratory are located separate cyanide outfits for testing ore by the cyanide process. There

is also located in this laboratory, a calcining furnace capable of being used as a reverbaratory or muffle roasting furnace, where large lots can be simply calcined, or a chlorination roast can be made by the hyposulphite treatment. There are arrangements for treating free milling gold ores by the amalgamation process, as well as cyaniding and tailings from this process.

Gas analysis is at present carried on in the chemical lecture room. There is a very complete set of Hempel's gas apparatus, and analyses are made of gases of combustion, reverberatory and blast furnace, illuminating gases, etc.

A dark room for students' use adjoins the balance room, which contains a large Kirchoff-Bunsen spectroscope and supplementary apparatus for qualitative analytical work in determining the presence of the alkali and alkaline earth metals by their volatilization in the non-luminous flame of the Bunsen burner. The spectroscope is provided with a scale for the determination of the exact location and relative position of the lines of the spectra, or, two spectra may be studied and compared at the same time.

A very complete set of the products of the metallurgical processes in use at the Boston & Montana smelter at Great Falls is installed in one of the Mineralogical Museum cases; this includes an exhibit of electrolytic slime together with ingots showing the exact amount of copper, silver and gold recovered from a definite amount of this slime. There are also several views of the interior of the smelter and adjoining properties, as well as a flow sheet of the concentrator connected with the plant.

The Butte Reduction Works is represented by a large number of its metallurgical products, including concentrates, tailings, mattes, sulphur-coated ore, etc.

The products of the Washoe smelter are also present, including samples of the copper cakes and anodes produced at Anaconda.

In addition to the mine models there are two metallurgical models in the Mineralogical Museum; one is a model of the Holthoff-Wetthey calcining furnace, as in use at the Butte Reduction Works, showing the device by means of which the rails and wheels supporting the harrows are kept outside of the furnace proper; the other is a model of the Pratt centrifugal ore sizer for sizing ore before it is run over Wilfley tables.

Several appropriate photographs and drawings decorate the walls of the museum and library; these include views of Montana mining towns, of the Washoe smelter at Anaconda, of the Boston & Montana smelter at Great Falls, and of various mines and mills about the State. In addition, there is a large drawing to illustrate the method of sampling in use at the Washoe Sampling Works, and several drawings of the coal washery of the Cottonwood Coal Company.

The new Metallurgical Laboratory will be completed during the current year and will be very completely equipped with ore dressing and metallurgical appliances. The building, on the metallurgical side, will contain a small cyanide plant of about 5 tons daily capacity, arranged to treat both sands and slimes, a chlorination plant, a 26-inch round blast furnace, a small Bruckner roasting cylinder, a reverberatory furnace and a bullion melting furnace. There will be bin capacity for about 200 tons of ores and slag, and the plant will be so arranged that the ore, in bulk, can be readily submitted to any treatment which may be desired. The building will also contain an additional set of assay furnaces and a laboratory in which

samples taken from the furnaces, leaching tanks, etc., can be analyzed.

DEPARTMENT OF MINING ENGINEERING.

A room 24 by 31 feet is provided on the second floor for lectures in the various branches of mining engineering. The drawing classes occupy one large, well-lighted room, 30 feet by 60 feet, on the third floor, and one room, 30 feet by 30 feet, on the second floor. Ample table room and individual drawer room are provided throughout; cabinets for filing drawings and drawing boards are also provided. A large collection of drawings furnished by various manufacturing companies of mining machinery is on hand and is used as an aid to the student in developing new work. The collection of parts of machines is gradually increasing. This material is of great assistance to the department in developing the work in machine design.

For the practical work in surveying the following have been provided: Six engineering transits; one from Buff and Buff, one from C. L. Berger & Sons, three from Gurley, and one from Keuffel and Esser. Four levels—one from Buff, one from Gurley, one from Keuffel and Esser and one from Berger. One solar compass and one sextant with artificial horizon, from Gurley; two aneroids by Short and Mason (London), and a collection of minor apparatus, including Brunton compass, clinometers, Locke levels, chains, tapes, plummets, shaft plumbing equipment, rods and flags, necessary in carrying on the work of the department. To this equipment has recently been added by donation a plane table with alidade, a Breithaupt and Sons' level with tripod and a Tacher's calculating instrument.

A mine model has been constructed in the school shops for use in the lecture room, which greatly facil-

itates the solving of many of the more complicated problems in mine surveying.

The Legislative Assembly of 1907 appropriated the sum of \$45,000 for the construction of a metallurgical laboratory at the Montana School of Mines. Such a laboratory will necessarily include ample provision for ore dressing. Plans for the ore dressing rooms of the new building are in course of preparation. They will contain one or more of each of the approved ore dressing appliances, arranged in such order as will permit the students to carry out complete tests for the mechanical treatment of various kinds of ore preparatory to the metallurgical treatment. The apparatus contemplated for this plant will include a battery of stamps and amalgamating plates, various types of ore crushers and rolls, elevators, trommels, sizing screens, jigs, Huntington mill, concentrating and slime tables, hydraulic classifiers, a magnetic separator, etc.

The museum of the school contains a very complete collection of the products from the ore dressing plants at the Butte, Anaconda and Great Falls smelters. These samples are extensively used in lectures on ore dressing, as they show in a most excellent manner the mechanical changes which a particle of ore undergoes during its travel through the various machines, designed to separate the valuable metal from its gangue.

On the tables of the school library may be found all the leading American technical magazines as well as many foreign publications. The library also contains a valuable collection of text books on all the subjects of civil and mining engineering, the use of which is open to all students upon application to the librarian. The office of the Professor of Mining Engineering also contains a large collection of cata-

logues, blue prints, and bulletins from leading manufacturers of mining, milling and smelting machinery. The school is indebted to these manufacturers for the supply of such catalogues and for the many extra copies which they have kindly furnished for distribution among the students.

Several mine maps, an ideal section of a Butte copper vein, a very instructive section through part of the Great Falls concentrator, and a great number of appropriate photographs and drawings decorate the walls of the museum and library; these include views of Montana mining towns, the Washoe smelter at Anaconda, of the Boston & Montana smelter at Great Falls and of various mines and mills about the State. There is a large drawing to illustrate the method of sampling in use at the Taylor & Brunton Sampling Works (now the Washoe Sampling Works) at Butte, and also several drawings of the coal washery of the Cottonwood Coal Company. Finally there are several diagrams, illustrating the relative production of copper, silver and gold in Montana and other states.

The various mine models, donated from time to time by leading mining companies of Butte, are exceedingly useful in demonstrating not only the geological features indicated on such models, but also the various phases and methods of shaft sinking, drifting, cross-cutting and stoping, practiced in the mines represented by said models.

DEPARTMENT OF GEOLOGY AND MINERALOGY.

General.—The Department of Geology and Mineralogy occupies eight rooms and part of two others, besides making occasional use of a drawing room. On the first floor is the Geological Museum with its overflow accommodated in a neighboring lecture room;

on the second floor are the Office, the Lecture Room and the Mineralogical Laboratory, while certain maps are provided for in the library; and on the third floor are the Mineralogical Museum, the Thin-Section Lathe Room, the Dark Room and the Storage Room.

The collections of minerals, of rocks, of fossils and of ores and country-rocks belonging to the department have each been subjected to a threefold division into museum specimens, lecture specimens and student specimens. The student collections are placed in drawers where they are accessible to the student at all times; the lecture specimens are kept in the office where they may only be examined in the presence of an instructor; and the museum collections, which consist of the rarer, the larger and more delicate specimens, are kept under the glass where they may be seen but not handled.

Of general usefulness in all courses of the Department of Geology and Mineralogy are the Storage Room, the Dark Room, the Lecture Room and the Office. These rooms and their contents will now be described, with the omission of certain special apparatus and collections which are more consistently described later. The Office is twenty-two feet long by twenty feet wide. It is fitted with desks and tables for the convenience of officers of the department, with cabinets for the various lecture collections and with book-cases for the departmental library. The Lecture Room is provided with large blackboards and furnished with a suitable desk and chairs. It is thirty-one feet long by twenty-four feet wide. One corner of the room is occupied by a geological relief map of the United States modeled on a section of a globe sixteen feet in diameter. This shows the topography as well as the areal geology of the entire country. The Dark Room on the third floor con-

tains apparatus and chemicals for photographic work. The Storage Room on the same floor contains materials for the museums or class-rooms which has not yet been prepared for study or exhibition.

Mineralogy.—The large set of crystals included in the lecture collection of minerals is used not only to illustrate the lectures in Crystallography but also as material for laboratory exercises. In addition to these real crystals, three series of crystal models are available, two of wood and one of celluloid. A reflection goniometer for the accurate measurement of crystal angles is installed in the Dark Room, while hand goniometers for laboratory work are kept in a case in the Mineralogical Laboratory. The stereographic projection of models and crystals is performed in the drawing room.

The Mineralogical Museum contains the museum collection of minerals. This has been separated into two parts: a systematic collection arranged according to Dana and an economic collection arranged according to Moses and Parsons. A collection of gold crystals belonging to the museum is ordinarily kept in a vault. It consists of about one hundred and fifty specimens collected from about twenty million dollars' worth of placer gold which passed through the Helena assay office in former years. The museum is thirty-one feet square and only a third of the floor space is occupied by the six cases of minerals. The remainder of the room is at present given over to the mine models which will be described later and to metallurgical exhibits.

The Mineralogical Laboratory is thirty-one feet square and contains six laboratory tables capable of accomodating thirty-six students. Each student is provided with complete apparatus for the rapid determination of minerals by physical and chemical tests.

A case in one corner of the laboratory contains a set of one hundred and seventy-seven specimens illustrating the physical characters of minerals. In another corner stands a cabinet containing two hundred and eighty-eight mineral species and varieties arranged according to Moses and Parsons; pycnometers, Westphal balance, Platner scales, burettes, agate mortars, and miscellaneous laboratory supplies are at hand in another case. A collection of minerals for laboratory determination by the students is kept in a set of drawers in the office. Here will also be found a case of chemical and mineralogical reagents and appliances, a tile-topped table, a hood and all the apparatus necessary for conducting qualitative and quantitative analyses of minerals and rocks.

Geology.—The Geological Museum occupies a room thirty-one feet square and four plate glass cases belonging to the museum have been placed in an adjoining lecture room. The museum has tables arranged next the windows on three sides and the remainder of the room is occupied by cases and cabinets.

For laboratory work in Structural Geology, there are two large cabinets, each containing thirty drawers, in which is kept the student rock collection arranged according to Kemp. Immediately above these drawers, arranged beneath glass, are series of rocks illustrating the more important structures and types. The lecture demonstration of different types of faulting is effected by the aid of a series of wooden models kept in the Office.

The laboratory exercises in Physiographical Geology are conducted on the tables in the museum. Two large cabinets, containing geologic and topographic maps respectively, furnish the material for this work. These cabinets are kept in the School Library.

Historical Geology laboratory exercises are also carried on in the museum. One case is filled with the larger and more perfect fossils.

Although laboratory work in economic geology is not required in the course given at the School, nevertheless a student collection of specimens of economic interest has been placed in the Geological Museum and is utilized in connection with the course in Mining Geology. Like the student rock collection, it occupies sixty drawers, and above it in glass cases have been placed some of the more interesting economic specimens. There are ten other show cases and one large wall case containing specimens belonging to the museum economic collection. The collection embraces specimens of copper ores from all the large mines of Butte, comprising average and picked samples, samples which are mixtures of several ore-minerals and those showing massive or crystalline varieties of a single mineral, specimens of the country rocks, mineral veins and slickensided samples of ore. In addition to the collection of Butte ores, there is a large collection of specimens of coal and of gold, silver, copper, and lead ores from the various mining districts of Montana. Besides this, there are samples of graphite, coke, molybdenite, scheelite, corundum, limonite, onyx, clay, gypsum, mineral paint, and oil from various parts of the state. Whenever possible these specimens were placed beside samples from other states for purposes of comparison.

Upon the wall of the Geological Museum hangs a colored diagram representing an "Ideal Section of a Butte Copper Vein." This was constructed by the Geological Department of the Anaconda Copper Mining Company and has been reproduced in print several times. The Lecture Room walls are hung with diagrams showing the relative production of various

metals in Montana and other states, and a map made at the School showing all the important mineral districts of Montana. In the Mineralogical Museum there is a fine set of mine models. The model of the Black Rock-Niagara workings was constructed of wood, tape and colored threads by R. G. Brown for the Niagara Mining Company. The Colusa Parrot and Never Sweat Mines are represented by four different models: one shows the geology of the veins by means of vertical sections on glass; a second shows all the mine workings of both mines by horizontal sections on glass; another shows the surface, the vein structure and the mine workings upon a painted wooden block cut and hinged in two places to show different vertical sections; and the fourth shows all the workings of both mines by means of wooden blocks representing the stopes, raises, winzes, shafts and so forth. This last model is accompanied by a map of the workings in the district of these mines made for the Colusa Parrot Mining Company. The Wappelo and Butte and Boston properties are shown by means of vertical sections on glass connected by appropriately-shaped and colored strips and rods of wood and metal. This model was made by C. C. Rueger.

For the summer work in Field Geology, the department is equipped with seven Brunton compasses, three aneroid barometers, geological hammers, tapes, a camera, Attwood clinometer, Abney mine level and a Keuffel and Esser compass and clinometer. A complete camp outfit is owned jointly with the Department of Mining Engineering.

Petrography.—In the Geological Museum is a case containing seventeen petrographical microscopes. Ten of these are of the French type, made by Nacet in Paris; and seven of the German type made by

Leitz in Wetzlar. These microscopes are all provided with the necessary attachments for ordinary petrographic work, and two of them, one Leitz and one Nacet, are of larger size than the others and are equipped with accessories for research work.

A specially constructed cabinet in one corner of the museum contains about three hundred oriented slides of minerals, about six hundred thin sections of rocks, and about one hundred slides of economic interest. The thin sections of rocks are all represented by hand specimens in the student collection of rocks which is kept in this museum and has already been described, so that the student may observe the microscopic character of the same rocks whose microscopic characters he is studying under the microscope. A set of one hundred and twenty-five wooden models of crystals of the more important rock-forming minerals is also available.

The Thin-Section Lathe Room contains complete equipment for making thin sections of rocks and minerals. There are two electrically driven lathes in this room: one is provided with two laps for rough and fine grinding respectively; the other with a wire and also with a wheel, both for cutting slices. Emery, Canada balsam, thick glass, slides, covers and all other supplies and accessories are at hand for use.

A camera for taking photo-micrographs is installed in the Dark Room.

DEPARTMENT OF MECHANICS.

This department occupies three rooms on the first floor. The lecture room has a seating capacity of forty persons, and is provided with modern lecture room conveniences, such as water, gas, electric current, etc. The lecture apparatus consists of a select equipment for illustrating the laws of mechanics,

electricity, sound and light. The physical laboratory is equipped with heavy tables and apparatus for the measurement of physical constants. The apparatus consists of the usual assortment required in the measurement of density, elasticity, force of gravity, the latent heats of fusion and evaporation, the mechanical equivalent of heat, etc. There is also a good photometer, together with the necessary accessories. For the measurements in electricity, there are provided ammeters, voltmeters, resistance boxes, Wheatstone bridges, galvanometers, batteries, keys, etc.

The engine and dynamo room is located in the basement of the building; there is installed here a gas engine of fifteen horsepower, from which is belted a line shaft driving direct and alternating current dynamos. A switchboard connects these machines with lines running to various parts of the building, also to motors and a rotary converter, and to a bank of transformers. It is possible to illustrate most of the connections in power transmission systems with the apparatus at hand as well as to perform many interesting tests. A storage battery of ten cells is also connected to the switchboard so that any number of them may be connected to any of the circuits for lecture or experimental purposes. The requisite voltmeters and ammeters for both alternating and direct current, rheostats, etc., are provided. The laboratory is also supplied with galvanometers, standard condensers, resistance boxes, etc., necessary for the more exact and complicated electrical measurements.

In connection with this laboratory there is a small shop equipped with the following metal working machines: one thirteen-inch screw cutting lathe; one sixteen-inch shaper; one twenty-two inch drill. The tool cabinets are provided with a good equipment of bench tools for both metal and wood work. There

is also a small blacksmith shop used for making and repairing tools and for giving such students as may desire it, practice in forge work in iron and steel.

In addition to the material mentioned above the testing laboratory has at its disposal a 100,000-pound Olson machine arranged for tensile, compression and shearing tests. The accessories consist of the following: One Olson compression micrometer especially designed for measuring the compression of stone cubes and other building material; one Olson improved deflection instrument for measuring the deflection of beams subjected to load; one Henning's improved micrometer instrument for measuring the compression or elongation of long specimens. The laboratory is also equipped with a cement testing outfit from Fairbanks, Morse & Co. All accessories, such as molds, sieves, etc., are at hand for making a thorough study of this important subject. The apparatus for making a complete indicator and brake test of an engine are provided, also the apparatus for making a study of the heating power of coals.

THE LIBRARY.

The number of publications in the library, departmental and others, is nearly 4,000. As a United States Depository for Public Documents, the shelves contain the issues of the United States Geological, and Coast and Geodetic Surveys; Reports on Forestry, Forest Reserves and Irrigation; and of the Naval Observatories and Engineering Corps. Besides these the library receives the official scientific reports of various state surveys, and of Mexico, Canada, Great Britain, France, Norway, Cape of Good Hope, New Zealand, and the states of Australia. In addition to this abundance of technical and scientific liter-

ature all the more important standard reference works are procured as they are published.

The leading scientific, mining engineering and geological magazines are to be found on the library tables, and as fast as the several volumes of these are completed they are bound and thus furnish in permanent form more or less complete discussions of the latest and most important advances that have been made in their several departments. To these are added the bound volumes of the proceedings of the great scientific societies, such as the Geological Society of America, the American Chemical Society, and the American Institute of Mining Engineers, etc.

A valuable collection of the standard works and treatises on the various branches of science taught in technical schools has been secured by donation.

MAGAZINES.

The following technical and general magazines and periodicals will be found in the library and in the rooms of the members of the faculty, where they may be freely consulted by the students:

- American Journal of Science.
- Bulletin of the Geological Society of America.
- Cassier's Magazine.
- Chemical Abstracts.
- Chemical News.
- Collier's Weekly.
- Economic Geology.
- Electrical World.
- Electrical Age.
- Electrochemical and Metallurgical Industry.
- Engineering.
- Engineering and Mining Journal.
- Engineering News.
- Harper's Weekly.
- Iron Age.
- Iron and Steel Magazine.
- Iron Trade Review.

Journal of the American Chemical Society.
Journal of the Association of Engineering Societies.
Journal of the Chemical Society of London.
Journal of Geography.
Journal of Geology.
Journal of the Geological Society of Tokio.
Machinery (Engineering Edition).
Mineral Industry.
Mineralogical Magazine.
Mines and Minerals.
Mining and Scientific Press.
Mining Reporter.
Mining World.
National Geographical Magazine.
Nature.
Neues Jahrbuch fur Geologie, Mineralogie, etc.
Outlook.
Popular Science Monthly.
Quarterly Journal of the Geological Society of London.
Salt Lake Mining Review.
School of Mines Quarterly.
Transactions of the American Institute of Mining Engineers.
Tschermak's Mineralogische und Petrographische Mittheilungen.

The following newspapers are kindly furnished by their publishers free of charge:

The Ravalli Democrat (weekly), Hamilton.
Great Falls Leader (daily), Great Falls.
The Missoulian (daily), Missoula.
The Tribune-Review (weekly), Butte.
The Basin Progress (weekly), Basin.

GENERAL INFORMATION.

BUTTE.

It is no longer necessary to call attention to the fact that Butte is one of the greatest mining centers of the world. The discoveries and developments of the past year, and the enormous investment of capital in the mines of this city by the leading financiers and mining men of this country and Europe have given to this locality such publicity that no one now needs to be told of its leading position in the mining world.

Following a long period in which its mineral product, though larger than that of any other field, was kept far below its capacity by reason of conflict of title to mining ground, a settlement has been effected which will permanently remove all such restriction in its output. New life has been infused, new mines located, and such aggregations of capital have been enlisted as promise a vast increase in its production for a generation to come. With this increase in production, there has come a largely increased demand for copper, and a consequent advance in prices, that must for some years to come make the mining of the red metal in Butte one of the most profitable industries of the world.

The great reduction plants that have heretofore handled the ore that comes from the mines of this city must be enlarged to treat the enlarged product. The modern devices for reducing the expense of treatment will be developed on a larger scale, and all of this increase in every department of the mining

industry goes to render this place the more desirable as a location for a mining school.

In a very important sense all these mining plants of every description are a part of the substantial equipment of the school, because its pupils are brought into daily contact with the men who are personally engaged in the various departments of this industry and are thoroughly conversant with all the details of the work.

EXCURSIONS.

To secure a more thorough and practical acquaintance with the subjects taught in the School of Mines, frequent excursions are made to some of the very extensive mining and metallurgical plants in the vicinity of the school.

It is believed that the location of the Montana State School of Mines is unrivalled in the opportunities it offers for such excursions. While in most other mining schools a journey of several hundred miles must be made, at heavy expense to the student, if he wishes to investigate the practical application of the methods and processes employed in the mine and smelter; the opportunity is here presented for daily observation of works, the development and product of which have given to Butte the reputation of being the greatest mining center in the world.

These excursions are made by the students of the school under the guidance of their instructors, at such times in their course as may be most advantageous to them; but, besides these regular occasions, through the kindness of the managers of the various plants, whenever an operation of unusual interest or importance is about to take place, permission is given to the mining classes to witness the same, under the guidance of their instructors.

Short excursions are also made from time to time to regions near by which illustrate the geological features of the Rocky Mountain system.

In addition to these comparatively short excursions, the freshmen spend six weeks of their summer vacation time in camp, where they are given fifty hours per week in learning the use of instruments, and in such exercises as are detailed on page 30. The sophomores, in like manner, spend six weeks of their summer vacation in underground surveys, in the mines, under the direction of the professor in charge of mining engineering, and in map drawing to show underground workings. In like manner the junior class spends six weeks making geological surveys in some one of the interesting geological fields of this and adjoining states.

Through the courtesy of the great mining companies, as well as the smaller operators, and individual miners, the students of the School of Mines have every proper opportunity of visiting these mining plants and observing the operations therein conducted. The great practical advantage that thus accrues to the mining student cannot be overestimated.

EXPENSES

Fees.—By the Act establishing the School of Mines, no charge for tuition is to be made where the student is a bona fide resident of Montana. Students from other states or countries will pay a tuition fee of \$25.00 per semester, or \$50.00 per year.

A registration fee of \$5.00 each semester will be required of all students. No deductions will be made to those who attend for only part of the semester.

Deposits.—To secure the State against loss for apparatus that may be broken or damaged by the student, a deposit is required at the beginning of the year from each one engaged in laboratory work.

This deposit is placed in the hands of the Treasurer of the Board of Trustees. Each student is charged with the apparatus issued to him. At the close of the year he is credited with such articles as he returns in good order. The balance of this account is then returned to him.

The following is the list of deposits that are required:

FRESMAN YEAR

General Chemistry and Qualitative Analysis.....	\$15.00
Surveying.	10.00

SOPHOMORE YEAR

Quantitative Analysis.....	\$15.00
Mineralogy.	10.00

JUNIOR YEAR

Metallurgy and Assaying.....	\$10.00
Mine Surveying	10.00

SENIOR YEAR

Petrography.	\$10.00
Metallurgy.	10.00

When the breakage exceeds the deposit the student will be required to make good the full amount of the damage done.

There are no dormitories connected with the school. Students will be expected to find board and lodging for themselves in Butte or its vicinity, and at such places as are approved by the faculty. The expense for board and lodging is not higher than in other important cities of the West. Good board can be secured at \$25 per month, while the cost of a good room large enough for two persons and including light and heat will be from \$15 to \$25 per month, according to location and the furnishings. For those who find it necessary to economize, there are few cities that afford as favorable opportunities for self-help as are found here.

LIST OF STUDENTS

Senior Class

Bowden, Malcolm.....	Helena, Montana
Ellis, Willis H.....	Butte, Montana
Foote, Frank A.....	Butte, Montana
Ketcham, Samuel H.....	Clinton, Montana
Lomas, Percy.....	Butte, Montana
Lowry, Thomas M.....	Butte, Montana
McLaughlin, William D.....	Butte, Montana
Meikeljohn, Archie B.....	Butte, Montana
O'Brien, Albert.....	Goldfield, Nevada
Patten, Earle.....	Phillipsburg, Montana
Proctor, Jr., Israel O.....	Great Falls, Montana
Proctor, Merton D.....	Great Falls, Montana
Sengbusch, Lawrence W.....	Great Falls, Montana
Schiffner, Otto E.....	Butte, Montana
Villars, Jesse R.....	Arkansas City, Kansas
Walton, Lee M.....	Dillon, Montana
Wren, Andrew A.....	Los Angeles, California

Junior Class

Brulo, William.....	Helena, Montana
Evans, James.....	Butte, Montana
Haines, Peter.....	Westresand, Loften, Norway
Harlan, Clyde C.....	Kansas City, Missouri
Hoffman, David A.....	Great Falls, Montana
Johnstone, J. Clark.....	Butte, Montana
Kane, Edward E.....	Butte, Montana
Kirby, Kenneth P.....	Butte, Montana
Little, David.....	Portland, Oregon
Loughran, Michael.....	Butte, Montana
Malloy, Edward E.....	Butte, Montana
Peters, Ira B.....	Butte, Montana
Stockett, Norman A.....	Bankhead, Alberta, Canada
Weigenstein, Henry J.....	Butte, Montana
Williams, Daniel J.....	Seattle, Washington
Young, William A.....	Giltedge, Montana

Sophomore Class

Condon, George.....	Anaconda, Montana
Cotter, W. T.....	Canton, Montana
Dyer, Burt W.....	Livingston, Montana
Furlong, Leslie P.....	Rockford, Illinois
Grunert, August.....	Butte, Montana
Heimerdinger, Vern.....	Butte, Montana
Howell, Henry.....	Butte, Montana
Jensen, W. H.....	Great Falls, Montana
LaMotte, Ross G.....	Great Falls, Montana
Ralston, Edward L.....	Dewey, Montana
Sherman, H. C.....	Helena, Montana
Stuewe, William.....	Helena, Montana
Sullivan, George.....	Butte, Montana
Tobin, Maurice.....	Butte, Montana

Freshman Class

Clinch, Ralph S.....	Butte, Montana
Copelin, Leonard S.....	Great Falls, Montana
Cosgrove, Mack.....	Missoula, Montana
Dailey, Le Roy N. A.....	Great Falls, Montana
Gottschalk, Charles.....	Helena, Montana
Hughes, Thomas.....	Anaconda, Montana
Kyle, Walter A.....	Butte, Montana
McElvenny, Linden.....	Butte, Montana
Murphy, Kane C.....	Butte, Montana
Ragen, William G.....	Townsend, Montana
Roach, James C.....	Butte, Montana
Sweeney, P. J.....	Winston, Montana
Tout, Charles.....	Butte, Montana
Wiedman, Edwin M.....	Pony, Montana

Special Students

Alamos, Gmo, A.....	Santiago, Chili
<i>Metallurgy.</i>	
Cornelius, B. J.....	Butte, Montana
<i>Metallurgy, Chemistry.</i>	
Corr, Frank R.....	Butte, Montana
<i>Chemistry, Mathematics.</i>	
Fogarty, Edmond A.....	Sandcliffs, Montana
<i>Mineralogy, Mathematics.</i>	
Gilham, R. E.....	Townsend, Montana
<i>Engineering, Metallurgy.</i>	
Soule, Vassar.....	Alburg, Vermont
<i>Metallurgy, Geology.</i>	
Tabor, John.....	Butte, Montana
<i>Geology, Surveying.</i>	
Wathy, R. L.....	Butte, Montana
<i>Metallurgy, Geology.</i>	
Wilson, William.....	Butte, Montana
<i>Assaying.</i>	

REGISTER OF ALUMNI

Class 1903

Bender, Louis V.....Anaconda, Montana
Chemist, Anaconda Copper Mining Co.

Class 1904

Balmforth, Alfred J.....Tombstone, Arizona
Mining Engineer, Old Glory Mining Co.
 Reese, Clara Clark.....Denver, Colorado
 Duling, Fred J.....Skidoo, California
Engineer, Skidoo Mining Co.
 Irelan, Arthur J.....Helena, Montana
Mining Engineer, County Surveyor.
 Kuphal, Henry E.....Missoula, Montana
Mining Engineer.
 Stevenson, Isabel Little.....Sumpter, Oregon
 MacRae, Lachlan D.....Goldfield, Nevada
Mining Engineer.
 McGee, John.....Rawhide, Nevada
Mining Engineer.
 Pauly, P. L.....Skidoo, California
Mining Engineer.
 Tallant, H. S.....Deer Lodge, Montana
Mining Engineer.

Class 1905

Archibald, George.....Butte, Montana
Engineer, Butte & Bacorn Mining Co.
 Brinton, O. F.....Butte, Montana
Mining Engineer.
 Corey, Clarence R.....Seattle, Washington
Assistant Professor of Metallurgy, University of Washington.
 Duthie, John M.....Butte, Montana
Assistant City Engineer.
 Elford, Basil.....Tonopah, Nevada
Mining Engineer.
 Mackel, Louis C.....Sumpter, Oregon
Mining Engineer, Eastern Oregon Mining Co.
 Pratt, Paul D.....Libby, Montana
Mining Engineer.
 Stevenson, Leon C.....Sumpter, Oregon
Manager, Orleans Gold Mining Co.
 Van Gundy, Jay.....The Dalles, Oregon
Mining Engineer.

Class 1906

Dugan, John F.....	Butte, Montana
<i>Surveyor, Anaconda Copper Mining Co.</i>	
Feeney, Charles W.....	Butte, Montana
<i>Surveyor, Anaconda Copper Mining Co.</i>	
Geiser, Herbert S.....	Butte, Montana
<i>Surveyor, Butte & Boston Mining Co.</i>	
Johns, John W.....	Butte, Montana
<i>Surveyor, Barker & Wilson.</i>	
Kane, Louis M.....	Butte, Montana
<i>Foreman, Berkeley Mine.</i>	
Warfield, Herschel J.....	Butte, Montana
<i>Draftsman, Boston & Montana Mining Co.</i>	
Wilson, T. Bert.....	Ely, Nevada
<i>Mining Engineer, Butte & Ely Mining Co.</i>	
Young, Siegfried A.....	Hereford, Arizona
<i>Mining Engineer, Butte & Arizona Mining Co.</i>	
Young, Arthur B.....	Libby, Montana
<i>Mining Engineer.</i>	

Class 1907

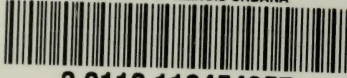
Adami, Arthur E.....	Butte, Montana
<i>Mining Engineer, North Butte Mining Co.</i>	
Bovett, Clifford A.....	Alaska
<i>Mining Engineer.</i>	
McCracken, Ralston H.....	Dillon, Montana
<i>General Engineering Business.</i>	
Reardon, Daniel.....	Butte, Montana
<i>Mining Engineer.</i>	
Schafer, William A.....	Butte, Montana
<i>Mining Engineer, Boston & Montana Mining Co.</i>	

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